DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

AERONAUTICAL ENGINEERING REVIEW

DECEMBER 1952

Leonardo DaVinci (1452-1519) gave to the world its first plans for a flying apparatus.

... out of this came Aviation

...an industry with vision

An industry that by its own imaginative design created the need for manufacturing with the same intensity of imagination and vision. Indiana Gear is such a manufacturer—a company of craftsmen dedicated to producing the finest in precision parts to back up the design intelligence of this great technologically-minded country.

This 450 H.P. main gear box of approximately 12 to 1 reduction for the Sikorsky S-51 Helicopter was fabricated in its entirety by I.G.W.'s skilled craftsmen.

INDIANA GEAR

INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA

Cover—The A3D, manufactured by Douglas Aircraft Company, Inc., is the Navy's first swept-wing jet-powered attack bomber and made its maiden flight from Edwards A.F.B., Calif., on last October 28. This aircraft can be used as a high-altitude attack plane or at low level for mine laying; it can also be adapted aboard its carrier for photoreconnaissance. The artist's drawing of the A3D, as it appears on the cover, shows the bomber as it takes off from one of the U.S.N. aircraft carriers.

Editor
Welman A. Shrader

Managing Editor
Bernoice H. Jarck

News Editor
Beverly A. Dodge

Book Reviews Editor
John J. Glennon

Reviews Editor
F. J. Harsaghy, Jr.

Editorial Assistant
Rita J. Turino

Technical Advisers
Hugh L. Dryden
Robert R. Dexter
S. Paul Johnston

Business Manager
Joseph P. Ryan

Assistant Manager
Hugh C. Judge

Adv. Production Mgr.
R. N. Lipner

Western Office

7660 Beverly Blvd., Los Angeles 36, Calif.

SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies, $0.50. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.50.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y. Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the Aeronautical Engineering Review are to be understood as individual expressions and not those of the Institute.

Copyright, 1952, by the Institute of the Aeronautical Sciences, Inc.

AERONAUTICAL ENGINEERING REVIEW

Vol. 11 **DECEMBER, 1952** **No. 12**

Contents

I.A.S. News 17
Guest Editorial . . . . . .Dr. Jerome C. Hunsaker 20

Articles

On the Possibility of Soaring on Traveling Waves in the Jet Stream . . . . . Joachim Kuettner 22
Flexural Fatigue Strength of Anodized 24ST Aluminum-Alloy Sheet. . . . . Charles B. Cliett 29
Flight Testing and Operational Problems of an Afterburner-Equipped Turbojet Installation. . . . . R. R. Templeton 32
A Miniature Supersonic Wind Tunnel . . . . . Patrick W. Powers 38

Reviews

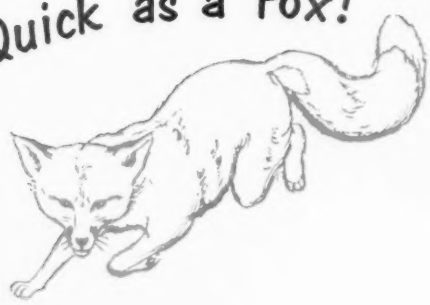
Aeronautical Reviews 69
Books 93

I.A.S. Preprints. 43
Services of the Libraries of the I.A.S. 44
List of Corporate Members 45
Personnel Opportunities 99
Special I.A.S. Publications 100
Index to Volume 11 105
Sherman M. Fairchild Publication Fund Papers . 113
Index to Advertisers. 115

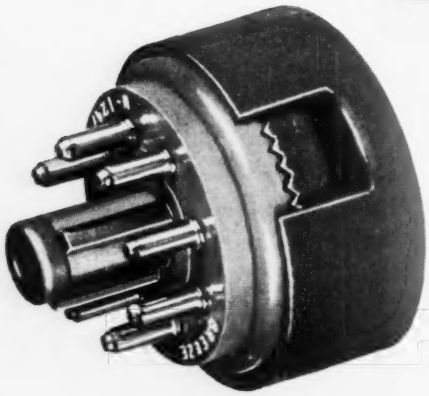
Published Monthly by the Institute of the Aeronautical Sciences, Inc.

RUGGED as a RHINO . . .

Quick as a Fox!



Two Special Purpose Connectors *by* BREEZE MARK

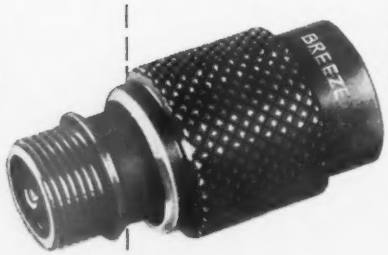


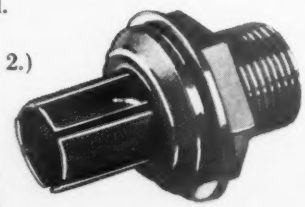
Battery Connectors

8-pin type for both A and B batteries used in all types of field communication equipment. "RUGGEDIZED" for extra security and long service life: polarizing stud is ALL METAL and all metal parts are cadmium plated and sealed with an iridite sealer. Cable may be brought out at any desired side position and locked. Handy bail makes removal from inaccessible places easy.

Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP – 416, Type 2.)





Receptacle Types: Round flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

We invite your inquiries on any problems concerning connectors. Our wealth of engineering experience in this specialty is at your service.

BREEZE

CORPORATIONS, INC.

41 South Sixth Street, Newark, N. J.

I. A. S. News

A Record of People and Events of Interest to Institute Members

American Engineers Win Trophy

Musick Memorial Trophy Awarded to Lindberg and Wheeler for Developing Sperry Engine Analyzer

TWO AMERICAN ENGINEERS, John E. Lindberg, Jr., and James W. Wheeler, M.I.A.S., were awarded The Royal New Zealand Aero Club's Musick Memorial Trophy for 1951 at the October 31 luncheon given by the Institute of the Aeronautical Sciences at the Wings Club in New York. The Messrs. Lindberg and Wheeler received this award for their joint development of the Sperry Engine Analyzer, an electronic device that detects, locates, and identifies detailed ignition and mechanical troubles in aircraft power plants during actual operation.

The Musick Memorial Trophy was presented to the American engineers by His Excellency, L. K. Munro, Ambassador of New Zealand to the United States, on behalf of The Royal New Zealand Aero Club. Christopher T. Clarkson, former British Air Attaché to the United States, represented The Royal Aeronautical Society, and Adm. L. B. Richardson, Past-President of the I.A.S., represented the Institute and acted as Toastmaster. Other notable guests included The Hon. T. Clifton Webb, Minister of External Affairs of New Zealand, and Air Commodore James L. Findlay, C.B.E., M.C., Air Attaché at the New Zealand Embassy in Washington, D.C.; and Paul J. Barringer, Director of the Office of Transport and Communications Policies, U.S. Department of State.

The Messrs. Lindberg and Wheeler accomplished their developmental work on the Sperry Engine Analyzer while Mr. Lindberg was in the employ of Pan American World Airways, Inc., as Staff Engineer for the Pacific-Alaska Division and while Mr. Wheeler was serving (as he currently is) as Head of the Engine Instrument Department of Sperry Gyroscope Company, Division of The Sperry Corporation. Mr. Lindberg is now President of Lindberg Engineering Company.

The Sperry Engine Analyzer permits an examination of the internal operating condition of an engine, cylinder by cylinder, while it is running. This device has been widely discussed and acclaimed for its contribution to flight safety, maintenance, cruise control, and schedule reliability. Two models of the analyzer are now being produced by Sperry an air-borne version to be used by flight engineers and a portable one for use by ground maintenance personnel. This electronic device is currently being employed in 39 types of aircraft, including military bombers, transports, and lighter-than-air; domestic and foreign air-line transports; and executive aircraft.

The Musik Memorial Trophy was established in 1938 by the citizens of Auckland, N.Z., in memory of Capt. Edwin C. Musick and six companions in Pan American's "Samoan Clipper" who were lost in the South Pacific on the first commercial flight from the United States to New Zealand on January 12, 1938. The trophy is awarded "to the group, body, or individual that has recently made the contribution, development, or improvement which by its practical application has become most

His Excellency L. K. Munro, *left*, congratulates James W. Wheeler, *center*, and Jchn E. Lindberg, Jr.

effective in furthering the safety of aircraft with special reference to transoceanic aviation, or directly so by increasing the efficiency of aircraft."

The Royal New Zealand Aero Club, which has its headquarters in Wellington, N.Z., is the trustee of the Musick Memorial Trophy. Britain's Royal Aeronautical Society and America's Institute of the Aeronautical Sciences both serve as nominating bodies for possible recipients of the trophy.

The Musick Memorial Trophy, originally set up as an annual award, was given in 1939 to Arthur Gouge, of Short Brothers, Ltd., England, and in 1940 to Robert J. Minshall, of Boeing Aircraft Company, U.S.A. At the beginning of World War II, however, it was decided to discontinue its presentation for the duration. Its current presentation to the Messrs. Lindberg and Wheeler is the first since that time.

New York Airways Begins Mail Service; I.A.S. Members on Board of Directors

On October 15, New York Airways, Inc., began formal operations as the first scheduled helicopter mail and parcel-post service in the New York metropolitan area. It is expected that this service will speed up the movement and delivery of air mail in New York.

The route currently being flown by this company is a triangular one among New York's three principal commercial airports—LaGuardia, New York International, and Newark. It is planned to extend this service ultimately to include flights between the above-named airports, the general post offices in Brooklyn and Manhattan, and 43 outlying communities in the states of New York (including Long Island), Connecticut, and New Jersey. A study of passenger, freight, and express transportation by helicopter in this area is now under way.

New York Airways has, as its operational equipment, three S-55 helicopters, built by Sikorsky Aircraft Division of United Aircraft Corporation. These three helicopters have been outfitted with emergency flotation gear to permit water landings in case of necessity.

Three of the eight members of the New York Airways' Board of Directors are members of the Institute. These three persons are: John L. Senior, Jr., M.I.A.S., who is serving as Chairman of the Board; Rear Adm. Luis de Florez, U.S.N.R. (Ret.), F.I.A.S.; and Grover Loening, I.A.S. Benefactor and Fellow. The remaining five board members: are Robert L. Cummings, Jr., President; Paul E. Battilana; William Shields, Jr.; Robert W. Dowling; and Knox Ide.

Necrology

Colonel James A. McDonnell

Colonel James Augustus McDonnell, U.S.A.F. (Ret.), A.F.I.A.S., died on September 18 in the U.S. Veterans Hospital, Bronx, N.Y., after an illness of several weeks.

Born in South Norwalk, Conn., on August 1, 1888, Colonel McDonnell was graduated in 1910 from Pratt Institute with a degree in Mechanical Engineering. He became one of the first civilians to enter Government service for the purpose of specializing in the development of the airplane as a military weapon.

During World War I, Colonel McDonnell was in charge of the U.S. Army's aircraft production and inspection in the midwestern part of the United States. After completing a competitive examination in 1919, he received the rating of Aeronautical Engineer in the U.S. Army Air Service and in 1920 was appointed to the staff of the Chief of Air Service.

Sometime later, Colonel McDonnell was made Manager of the Eastern District for the U.S. Army Air Corps, a position that he held for many years. In this post, he supervised U.S.A.A.C. contracts for aircraft and engine construction, including engineering development and design changes.

Since World War II, Colonel McDonnell had chairmanned the Aeronautical Education Commission of the City of New York and aided in the organization and development of the Manhattan School of Aviation Trades.

He is survived by his widow, Ethel McDonnell; a son, James A. McDonnell, Jr.; and a daughter, Mrs. Frances Doyer.

Albert E. McPherson

Albert Eugene McPherson, M.I.A.S., died several months ago at his home in Chevy Chase, Md. He was 44 years old.

A native of the District of Columbia, Mr. McPherson attended McKinley Technical High School there, from which he was graduated in 1926. That same year, he joined the staff of the National Bureau of Standards and enrolled as a student at George Washington University. He received his Bachelor of Science degree in Mechanical Engineering in February, 1933.

Mr. McPherson was engaged for many years in the National Bureau of Standard's aeronautical research program, which extends from the development of temperature-sensing devices for jet engines to the stress analysis of aircraft structures. Mr. McPherson's primary field of research was in aircraft structures and materials.

In Mr. McPherson's capacity as Senior Materials Engineer in the Bureau's Aircraft Structures Group, he supervised groups of engineers concerned with aircraft structural problems, development of special purpose instruments, and evaluation of commercial instruments. Mr. McPherson held patents on two types of accelerometers used in his work. During his years at the Bureau, he authored a large number of technical papers published by technical societies such as N.A.C.A. and N.B.S.

Mr. McPherson is survived by his widow and a daughter.

Colonel Augustus Post

Colonel Augustus Post, an aeronautical pioneer, died in a New York hospital on October 4 after suffering a heart attack. He was 78 years of age.

A native of Brooklyn, N.Y., Colonel Post began his long and eventful career in aviation with a balloon flight at the 1900 Paris Exposition. This was followed by many other balloon flights, including one in October of 1909 in which he and Clifford B. Harmon (of Harmon Trophy fame) established endurance and altitude records for free balloons.

Colonel Post's activities in the early days of aviation are far too numerous to list here. However, a few of the highlights of his career are as follows: He built and flew gliders in 1908, piloted dirigibles in 1909, and learned to fly heavier-than-air machines in 1910 at Hammondsport, N.Y. He was the thirteenth person in the United States to learn to fly. In 1905, he was a co-founder of the Aero Club of America and served as its Secretary until its reorganization into what is now the National Aeronautic Association. He was a timer when Orville Wright made his first demonstration flight for the U.S. Army at Fort Myer, Va.

It was Colonel Post who suggested to Raymond Orteig the idea of offering a $25,000 prize for an airplane flight from New York to Paris. Colonel Post wrote the conditions of the Orteig prize offer, which was won by Charles A. Lindbergh in 1927.

A.R.D.C. Publishes Contractors' Guide

A new 32-page booklet entitled *Research and Development in the United States Air Force* was recently issued by the Air Research and Development Command as a guide to contractors. Written to acquaint industry with the latest procurement and contractual procedures within the A.R.D.C., the publication explains the mission, organization, and contractual relations program of the command. It also includes an outline of the specific fields of research in which this organization is interested.

Copies of this booklet may be obtained by addressing all requests to the Commanding General, Headquarters, Air Research and Development Command, P.O. Box 1395, Baltimore 3, Md., Attn: Director of Procurement, Contractors' Relations Office.

Attention Members!

All Members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review.*

News of Members

▸ **Charles Adler, Jr.** (M.), Consulting Engineer, presented the original letters patent for a number of his inventions to New York University's College of Engineering through the Guggenheim School of Aeronautics. These letters patent covered basic aviation safety devices, including flashing signal lights and the aircraft proximity indicator.

▸ **Rear Admiral Thomas S. Combs,** U.S.N. (H.M.), Chief, Bureau of Aeronautics, Department of the Navy, was sworn in recently as a member of the N.A.C.A.

▸ **William Coney** (A.M.), Planner and Estimator, Ferrous and Non-Ferrous Metals, U.S. Navy, Corpus Christi, Tex., was recently designated as "Airpower Associate" by the Air Force Association in recognition of his "active interest in airpower for national security and world peace."

▸ **Ralph S. Damon** (F.), President, Trans World Airlines, Inc., is the recipient of the recently authorized Bronze Medal of Honor of Athens, Greece, "in recognition of his exceptional feelings and his noble efforts towards the City of Athens." The presentation was made by the Mayor of Athens. . . . In a recent action of the Board of Directors of Sheraton Corporation of America, Mr. Damon was elected a member of that body.

▸ **Dr. C. C. Furnas** (F.), Director, Cornell Aeronautical Laboratory, was named Chairman of the Committee on Guided Missiles, Research and Development Board, Department of Defense. Dr. Furnas succeeds Dr. Clark B. Millikan (H.F.), Director, Guggenheim Aeronautical Laboratory, California Institute of Technology.

▸ **Doctor Professor Guiseppe Gabrielli** (F.), Director, Technical and Project Division, Aeronautics Department, Fiat, s.p.a., Italy, was in charge of the design work for the Fiat G49 trainer, now a NATO production. The G49-1 and G49-2 are powered by the Alvis Leonides 502/4 and Pratt & Whitney R-1340 reciprocating engines, respectively.

▸ **Dr. Newman A. Hall** (A.F.) has been appointed Director of the Engineering Sciences Division, Office of Ordnance Research, U.S. Army. Dr. Hall was given a leave of absence by the University of Minnesota, where he is Professor of Mechanical Engineering and Head of the Heat and Power Division of the Department of Mechanical Engineering.

▸ **Hall L. Hibbard** (F.), Vice-President—Engineering, Lockheed Aircraft Corporation, was recently made a member of Lockheed's Management Policy Committee.

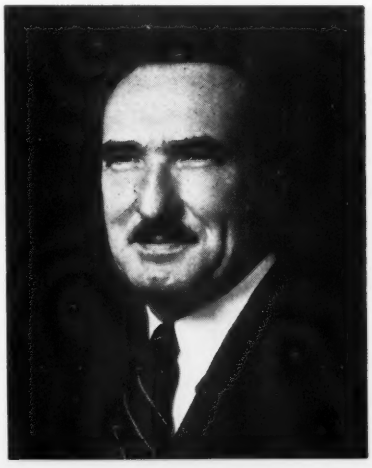
▸ **Stanley Hiller, Jr.** (T.M.), President, Hiller Helicopters, recently organized Hiller Engineering Corporation. This new company, located at San Mateo, Calif., will produce a non-aviation product.

▸ **William P. Lear** (A.F.), Chairman of the Board and Director of Research and Development, Lear, Incorporated, was elected to the Board of Trustees of the Lovelace Foundation for Medical Education and Research.

▸ **Carl B. Squier** (A.M.), Vice-President of Lockheed Aircraft Corporation, is now serving as Assistant to the President of the corporation.

HEADS AIR LINE

Harold R. Harris (F.) was named President of Northwest Airlines, Inc., succeeding Croil Hunter who becomes Chairman of the Board of the company. This change is effective January 1, 1953. Mr. Harris, a graduate of California Institute of Technology, has been serving recently as Vice-President of the Atlantic Division, Pan American World Airways, Inc. Before joining Pan American, he had been Vice-President and General Manager of American Overseas Airlines.



Members on the Move

The purpose of this section is to provide information concerning the latest affiliations of I.A.S. members. All members are therefore urged to notify the News Editor of changes as soon as they occur.

Edward T. Armstrong (M.), General Works Manager, Toscony Fabrics, Inc. Formerly, Research Administrator, Battelle Memorial Institute.

Allan A. Barrie (M.), Vice-President, Aircraft Engineering & Maintenance Company. Formerly, Sales Manager, Atlantic Division, Transocean Air Lines.

Harold L. Bloom (T.M.), Engineer—Aerodynamics, General Electric Company. Formerly, Aeronautical Research Scientist, Lewis Flight Propulsion Laboratory, N.A.C.A.

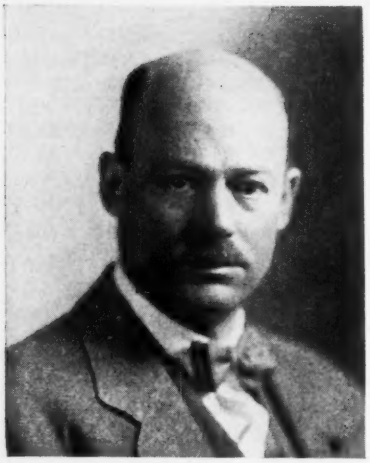
Second Lieutenant Warren F. Clement, U.S.A.F. (T.M.), Engineer, Directorate of Armament, Headquarters, Air Research and Development Command. Formerly, Air Training Command, Lowry A.F.B., Colo.

Aram Dervishyan (T.M.), Engineer, Engineering Research, Engineering Department, University of California at Los Angeles. Formerly, Student of Aeronautical Engineering, California Institute of Technology.

Captain Joseph E. Dodson U.S.N. (M.), Navy Member, Executive Directorate, Aircraft Production Resources Agency, Wright-Patterson A.F.B., Ohio. Formerly, Director, Fiscal Division, Bureau of Aeronautics, Department of the Navy, Washington, D.C.

Jean H. DuBuque (M.), Executive Director and Secretary, Corporation Aircraft Owners Association, Inc. Formerly,

(*Continued on page 46*)



Guest Editorial

Aeronautics—Some Social Aspects

Excerpts from a paper read before the Eighth International Congress for Theoretical and Applied Mechanics at Istanbul, Turkey, August, 1952

by Dr. Jerome C. Hunsaker

Chairman, N.A.C.A., and Past-President, I.A.S.

The significant scientific discoveries of the past have grown out of the free exchange of ideas among scientists of many nations. From the progress of science in our free society, an advancing technology evolves giving that society new tools to cope with its environment.

Consider the social impact of a new technology—aeronautics—which has evolved from applied mechanics in the first half of this century. The science of aerodynamics has been created in our lifetime out of the somewhat sterile nineteenth century hydromechanics of ideal fluids. The very form of the modern airplane is an adjustment to aerodynamic forces. Applications of structural mechanics lie behind the strong light structure of the modern airplane. Similarly, the science of dynamics has given us the gyroscope and the autopilot to permit safe flight for long hours in darkness and rain. Thermodynamics has been applied to create aeronautical power plants of previously unknown lightness and reliability. The modern airplane is made possible by the work of the international fraternity of scientists and is made available to society by inventors and engineers.

For Americans, it may be pleasant to think that the Wright brothers invented the airplane in a flash of genius and so realized the age-old dream of human flight, but this would be to capture only a portion of truth. However, the Wrights were the first men to fly, and they did devise and use a practical means for controlling their airplane in pitch, roll, and yaw. Had they not succeeded, it now seems certain that someone else would.

The time was ripe, the incentive great, and the basic concepts of the airplane and its propulsion existed. Mechanics was highly developed and ready for engineering application.

The airplane was born into a society able and ready to lavish all the resources of the machine age on the mechanical infant. The airplane was also born into a time of abundant energy from oil and at a time of violent nationalism. Great states were changing in relative power and were strained by economic pressures and instability. The twentieth century opened with the Russo-Japanese War and soon experienced the first World War.

It is no wonder that the airplane was at once taken up for intensive development by those countries that foresaw its military possibilities. In the succeeding years we have witnessed the progressive conquest of the air. While the airplane's rapid development into a practical vehicle was a consequence of the state of the society into which it was born, it soon began to change that society. Every person alive today is affected. There is a change in his relation to distant places and peoples. Traditional geographical barriers have disappeared, and the air presents a clear route to those distant places and peoples—a route for trade and the interchange of visits and ideas.

Likewise, the air can be a route for the arrival of sudden destruction. Air power reaches into the interior of a country and to islands formerly isolated by the sea and gives a new and frightening weapon to an aggressor.

Just now, the divided world is in a state of strain and many wish there were no airplanes with bombs to destroy the illusion of isolation. The times are no doubt dangerous, but that is not a new condition. Man has always feared a fiery end. The threat should impel nations to prudence and common sense, just as the Last Judgment of religion is an incentive to individual virtue.

There may be an historical parallel with ships. In the Mediterranean, sea power served trade and colonization and likewise war. The sea power of Elizabethan England led to an immense expansion of overseas enterprises. The golden age of Elizabeth and Shakespeare came to full flower with the opening of the sea as a universal highway.

The airplane is relatively new, but air power has already profoundly affected the outcome of a great war and still constitutes a threat to the security of great nations. In its civil applications, however, the airplane has yet to attain its potential world-wide utilization. But air transportation is already well established and is growing as fast as political, economic, and technical conditions permit.

Since Charles Lindbergh's famed Atlantic flight, approximately 1,500,000 ticket-holding passengers have flown across the Atlantic Ocean by scheduled air-line service, according to the International Air Transport Association. Probably an equal number have crossed on military and nonscheduled air transports. This summer more than 1,000 passengers flew across the North Atlantic every day.

The airplane of today has come a long way from the Wright airplane of 49 years ago. The basic type has continued to the present day, but its performance was rapidly improved by application of the advancing technology of the new century.

Orville Wright was not unaware of the military value of the airplane, since his first sale in 1908 was to the U.S. War Department. However, he always contended that he and his brother Wilbur thought of their airplane as a contribution to international communications, trade, and good will. Perhaps the next 50 years will prove him right in the long run.

Designers were at first the inventors; then engineers and scientists took over. The demands of the airplane led to the creation of strong light alloys, high-octane gasoline and high-output engines, and special operating equipment using radio, radar, and autopilots. Old ideas for a gas turbine were resurrected and applied with spectacular success to jet propulsion.

Taking speed records of propeller-driven airplanes as a measure of progress, the increase has been from about 40 to nearly 500 m.p.h. or at a rate of some 10 miles per year of effort. Simply projecting this trend suggests that the next 50 years should bring the speed record to 1,000 m.p.h. A fallacy must be present here, because the newspapers inform us that jet-propelled research airplanes have repeatedly flown at supersonic speeds.

Closer examination of the position shows that the jet-propelled airplane is not the airplane of the Wright brothers; something new and revolutionary has been added. A radically lighter and more powerful means of propulsion, eliminating the propeller, is a mutation that upsets the trend of statistics of past growth. The propeller-driven airplane has indeed made a normal growth curve, topping off between 1940 and 1950, with a maximum sea-level speed below 500 m.p.h.

The performance of jet-propelled airplanes is too recent to establish a trend from which to venture a forecast. All we know is that we shall have to do with a new kind of airplane to which vastly increased thrust can be applied.

The trends of technical progress are usually evident from a comparison of current designs with research data not yet applied, but there is always a time lag before research findings come into general use. For example, it is evident that the jet-propulsion gas turbine is revolutionary in its effect of affording more power to modern airplanes. The reciprocating engine is mature, and efforts to improve it have reached a stage of diminishing returns. The gas turbine is simpler, lighter, and more compact. Its big disadvantage is its youth and consequent occasional unreliability and a tendency to extravagance. Youth will be outgrown and, hence, one may safely predict that reliability and economy will be established.

Air transport cannot proceed at once to exploit many possibilities of the art suggested by current research. A number of difficult problems must first find practical solutions. The public is conditioned to expect uninterrupted progress, but the trees do not grow to the sky. There are always limitations in any art, either

(*Concluded on page 31*)

Aeronautics in the Mid-Century

A noteworthy companion piece to Dr. Hunsaker's paper, from which these excerpts have been taken, is his book under the above title just published by the Yale University Press. No one could be better fitted to review the implications of the conquest of the air. He not only took part in most of it, he led much of it. His book sets up a philosophical background against which aeronautical engineers and scientists may evaluate their own activities in proper scientific, economic, and social perspective. It is an important addition to aeronautical literature. S. P. J.

On the Possibility of Soaring on Traveling Waves in the Jet Stream

*Joachim Kuettner**

Air Force Cambridge Research Center

Introduction

MANY SAILPLANE PILOTS and meteorologists have looked for the possibility of using traveling instead of stationary waves for cross-country soaring flights. Visual observations and, more recently, time-lapse pictures have shown that waves of this kind exist. One type of traveling gravitational wave seems to be connected with cold fronts and has been called "prefrontal wave" by Georgii. In the last year, evidence has accumulated which shows that another kind of traveling wave exists in connection with the jet stream. The following discussion deals with the possibility of traveling "jet-stream waves." If used by gliders, the full speed of the jet stream could be transformed into ground velocity of the sailplane, and the high level of the jet stream (around 30,000 ft.) might provide an additional flight range.

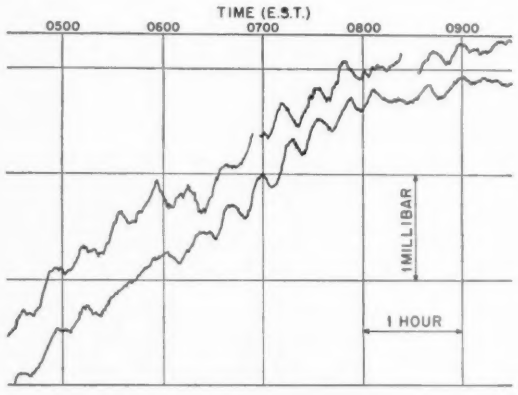
The atmospheric jet stream is a relatively narrow but extremely long band of high winds imbedded in the general westerly circulation. Its width is only a few hundred miles; its length can reach over 1,000 miles, and its position changes from day to day. One of its main features seems to be a strong vertical increase in wind velocity around the 20,000-ft. level (near 500 mb.), with an even stronger decrease in the substratosphere at about 40,000 ft. (200 mb.). The core of the jet stream lies usually between 30,000 and 35,000 ft., not far from the tropopause, with maximal wind velocities between 100 and 200 knots. Violent weather developments occur frequently in the immediate neighborhood of the jet stream. The dynamics and structure of the jet stream are not as yet well known.

Observational Evidence

The existence of traveling gravitational waves in the jet stream was first suspected when a sailplane flight in the jet stream last year showed oscillations in the wind speed similar to those observed in microbarographic traces taken on the ground under jet-stream conditions aloft.

It has been known for a long time that a sensitive barograph shows, almost constantly, atmospheric pressure waves. The amplitude of these oscillations is of the order of 1/10 mb., and the period ranges all the way from 5 min. to more than 1 hour. Most frequently observed are periods around 10 min. However, under certain (rather rare) conditions, one finds a pronounced type of pressure wave, whose amplitude is three or five times larger than usual and whose period lies generally between 20 and 30 min. During the last year, the Terrestrial Sciences Laboratory of the Air Force Cambridge Research Center has undertaken an investigation of atmospheric pressure oscillations. Comparison of the microbarograms with synoptic and upper-air maps revealed that the described pressure wave is generally connected with a jet-stream situation in the high troposphere. As far as can be seen now, the existence of the jet stream is a necessary, but not a sufficient, condition for the occurrence of these waves. A triangular system of microbarographic stations near Boston will be used to determine their wave lengths and propagation speed. Preliminary results show that, in agreement with visual observations, the pressure waves travel with the jet stream, however, with a slower speed. In other words, the waves propagate relative to the jet stream against the wind. The wave length probably exceeds 20 km.

The period and wave length indicate that the waves are gravitational in nature, so that oscillations in the vertical, as well as in the horizontal, component of the wind velocity should be expected. Figs. 1, 2, and 3

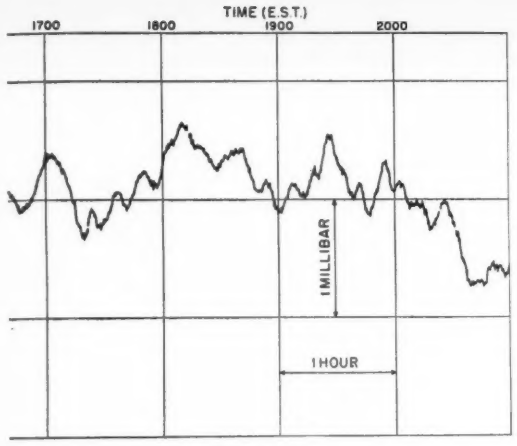


MICROBAROGRAMS
27 APRIL, 1951
UPPER CURVE = WATERTOWN, MASS.
LOWER CURVE = IPSWICH, MASS.
DISTANCE APART = 30 MILES

FIG. 1.

Presented at the Symposium on Motorless Flight, Twentieth Annual Meeting, I.A.S., New York, January 28-February 1, 1952.

* Geophysics Research Directorate.



MICROBAROGRAM
12 APRIL, 1951
WATERTOWN, MASS.

FIG. 2.

show examples of this type of microbarographic pressure wave measured near Boston.

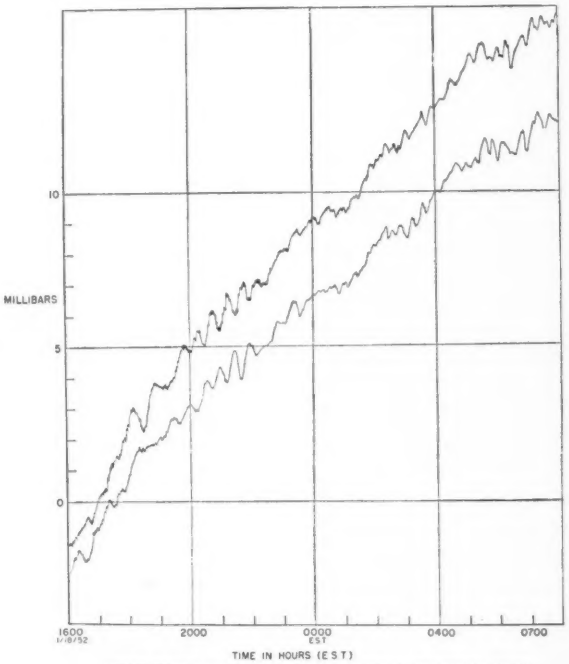
In the afternoon of February 25, 1951, the author encountered oscillations of a similar type while flying a sailplane in the leewave of the Sierra Nevada. Fig. 4 shows the barogram of this flight. *ST* marks the start in tow, *R* the release, *L* the landing, and *A* the point when the sailplane hovered for a while over the same spot at about 30,000 ft. with zero lift and a true speed of approximately 70 m.p.h. (42 m.p.h. indicated). The airflow was completely laminar at this altitude. After a few minutes, the glider began slowly to drift backward, and the forward speed had to be increased. Yet, the wind continued to speed up, and, at the first arrow on the picture, a true velocity of 110 m.p.h. (65 m.p.h. indicated) was necessary to compensate for the wind. At this speed the sailplane lost altitude because of its increased rate of sink, and it was hard not to be pulled into the downdraft area where one can lose 10,000 ft. altitude in a few minutes. This difficult situation did not last longer than about 8 min. Then the wind slowed down continuously until near point *B* on the picture, again a flight speed of 70 m.p.h. (42 m.p.h. indicated) was sufficient. But there was not much time to relax. After *B*, the whole cycle started over again, and, at *C*, the flight had to be terminated because of the late time of day. *L* is the landing.

The variation of the vertical wind component is of course overshadowed by the strong variation in sinking speed of the glider because of the change in flight velocity. Also the varying position with respect to the leewave obscures the time variation of the vertical wind component.

As to the interpretation of this flight, one must recall that the stationary leewave is used here merely as an elevator to lift the glider into the 30,000-ft. level. Apparently, the oscillations of the wind field travel through the leewave and are measured by the glider pilot while hovering on the standing mountain wave. Like an observer, he watches the wind field from the slope of the leewave. A project of this kind is now being undertaken by Robert Symons, of Bishop, Calif. The results are recorded by drift meters, an inclinometer, and lapse-time cameras pointing to the ground and the instrument panel.

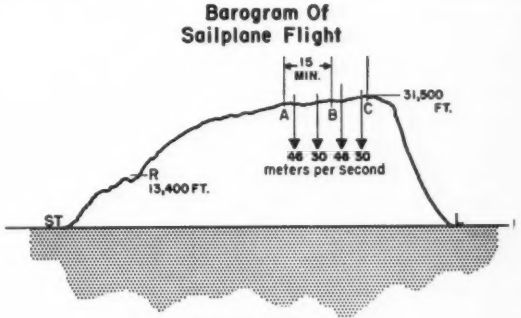
The prevailing meteorological conditions this day show that the flight was made at the northern edge of a developing jet stream over southern California. Twelve hours later, the jet stream intensified over Arizona with a maximum of over 140 knots. At 40,000 ft., a speed of 160 knots was measured.

In connection with a study of the "Sierra Wave," the Weather Bureau took daily wind measurements with double theodolites at Bishop. Fig. 5 shows the upper winds over Bishop about 4 hours before the flight.



UPPER CURVE = MURPHY GENERAL HOSPITAL WALTHAM, MASS.
LOWER CURVE = WESTON OBSERVATORY WESTON, MASS.

FIG. 3. Microbarograms—January 18, 1952.



BISHOP, CALIF.
2-25-1951 15:30—17:30 P.S.T.
J. KUETTNER
SAILPLANE PRATT-READ N63197

FIG. 4.

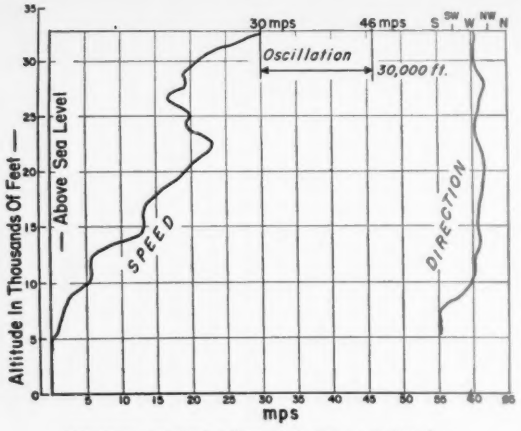


FIG. 5.

Also the oscillation measured by the sailplane can be seen in this picture. If the wind speed in high levels varies such that after 10 min. the wind in the same level is 50 per cent higher than the one just measured, one has to consider our upper-wind data with more reservation. Provided that our flight observation can be generalized, it would appear advisable to draw the isotachs in upper-air maps according to the contours rather than after individual wind soundings.

It seems that at the present time there is no device in existence which allows us to measure the time variation of the wind in high levels. Since our pibals are always moving vertically, any change of wind is interpreted as a change with height rather than a change with time. However, the oscillations of wind velocity with height, as seen on many wind soundings, might be variations of wind with time during the ascent of the balloon. This possibility will affect the interpretation of wind measurements in the forecast of upper winds, especially if the winds are extremely strong and the upper-wind data scarce due to low angles of ascent of the balloon.

It was not difficult to link the observation from the sailplane and from the microbarograms, since the periods, as well as the upper-wind conditions, are similar. If the described type of pressure wave is an image of gravitational waves traveling in the jet stream and if the vertical component of the wave motion is large enough, it should be possible to fly motorless on a jet stream between 20,000 and 40,000 ft. over a long distance. Even if the individual waves die out within 1 hour or so and if one wave system is 100 miles from the next one, it should be possible to pick up the waves by a high-performance glider, since the range of the sailplane is large at this altitude. However, until we have gained more quantitative data, the conclusion that cross-country flights in sailplanes might reach continental dimensions is speculative.

The question now arises: Is there a physical base for such a phenomenon, and what is the mechanism that produces it?

PHYSICAL MECHANISM

In the case of the leewaves, we know that a permanent pressure disturbance is produced by the mountain ridge and that under all possible waves one wave length is selected, which propagates with the same speed as the wind but in the opposite direction. For the traveling waves, a temporary pressure disturbance or an instantaneous pressure pulse might be sufficient, such as turbulence in a shear zone, frontal convection, etc. Since every pulse can be considered as a superposition of all kinds of waves, the questions arise: Will one wave length predominate over the others? How will this wave propagate? Will it die out or will it grow with time?

The usual way to approach such a problem is to set up the equations that govern the motion of the atmosphere, to eliminate the different variables with exception of the one in which one is most interested (for sailplane flight, this will be the vertical motion of the air), and to find a differential equation that can be solved under reasonable boundary conditions. Then one tries to interpret this solution from a physical standpoint. However, after having done that, it might be advisable to report the answer from the other end. By giving the physical interpretation first, it is easier and more interesting to follow the theoretical derivation. We shall try to do that.

Every modern pilot is familiar with the meaning of the word atmospheric "stability." He knows that the stability is determined by the lapse rate—i.e., temperature stratification—and that an unstable atmosphere produces thermal convection and a stable atmosphere produces either smooth air or wave motion. What he generally does not know is that the lapse rate is only one of several quantities that determine the stability of the atmosphere, although it is the most important one. The other terms that are of interest here are dependent on the change of wind with height. Special attention will be given to these terms in dealing with a jet stream.

If we consider a certain height and find that the lapse rate is stable at that elevation but that the wind speed is stronger above and smaller below this level, then this increase of wind with height tends to increase the stability of the atmosphere at the height considered. A decrease of wind with height has a destabilizing effect. However, in general, the thermal stability is much more effective than this wind-shear term and will be neglected in this consideration.

More important is the curvature of the vertical wind profile or, better, the rate of change of wind shear with height. If a "positive wind shear" (positive equals wind increasing with height; negative equals wind decreasing with height) is strongly increasing with height (or a negative decreasing), it can over-

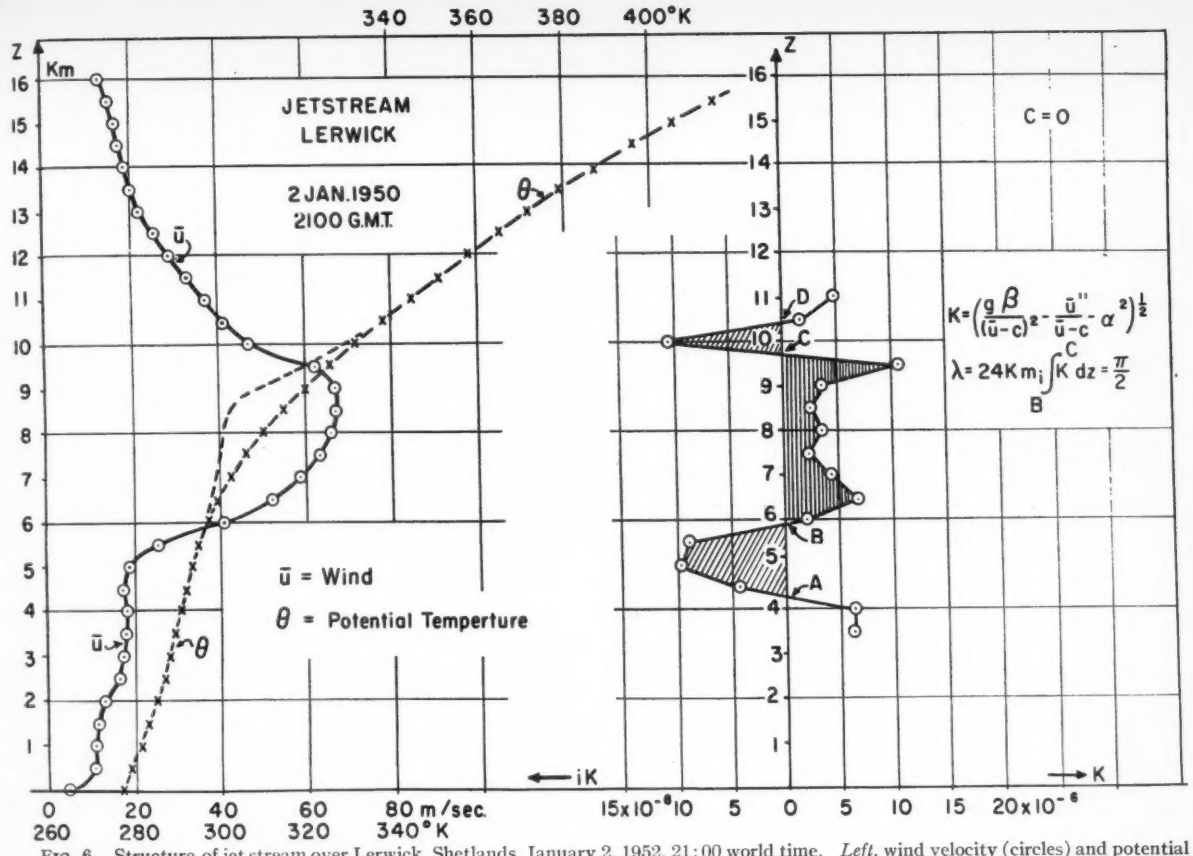


FIG. 6. Structure of jet stream over Lerwick, Shetlands, January 2, 1952, 21:00 world time. *Left*, wind velocity (circles) and potential temperature (crosses) plotted against altitude. *Right*, total stability (K and iK, respectively) plotted against altitude for phase speed $c = 0$ m. per sec.

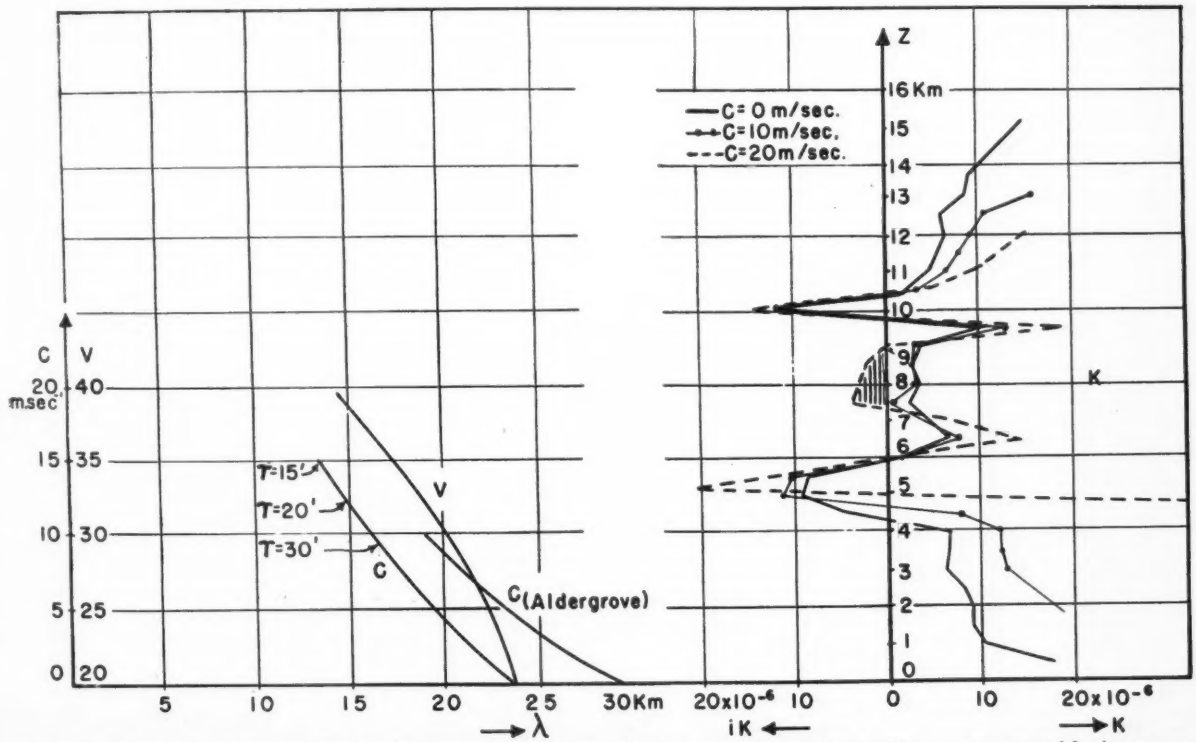


FIG. 7. Wave velocity and stability in a jet stream. *Left*, phase velocity c and group velocity v with respect to ground for jet-stream condition of Fig. 6 over Lerwick, Shetlands, and over Aldergrove, Ireland. τ denotes wave period on ground. *Right*, total stability plotted against altitude for three phase speeds of waves in jet stream over Lerwick.

compensate the thermal stability and produce instability. As a consequence, convection can develop even in a thermally stable atmosphere. However, it might be preferable to call that "turbulence." On the other hand, a decreasing positive wind shear (or an increasing negative) might have a strong stabilizing effect. In a typical jet-stream profile, the curvature changes sign and is of the same order of magnitude as the well-known thermal stability.

There is still another effect of the wind on the stability. In comparing two levels with different wind speeds but with the same lapse rate, it will be found that the higher the wind speed, the lower the stability, regardless of the wind-shear terms. Because of this fact and the large lapse rate in the upper troposphere, we find generally a minimum of stability just below the tropopause. However, in the jet stream, this can be quite different, since the curvature of the wind profile cannot be neglected.

We assume now a wave motion in the atmosphere which propagates horizontally. It turns out that the stability in a certain level is not the same for different wave lengths, the general tendency being that the smaller the wave length, the smaller the stability.

Let us consider a wave of a certain horizontal wave length. What happens if a portion of the atmosphere, say, a layer between 20,000 and 40,000 ft., is stable for this wave length but is unstable above and beneath the layer? In a layer with varying stability, waves do not propagate only in horizontal direction but also in vertical direction, with a vertical speed depending on the varying stability. If a wave, created by some disturbance, comes in contact with the upper or lower boundary of the stable layer, it behaves similarly to a light wave that contacts a layer of different density. Dependent on the angle of incidence and the density discontinuity, the light is partially or totally reflected. In our case, it turns out that the wave is totally reflected at the boundaries if it arrives there with a certain phase. The wave that is reflected downward at the upper boundary and the wave that is reflected upward at the lower boundary combine so that they form a "standing wave" (not to be confused with the "standing mountain wave," which should preferably be called "stationary mountain wave"). This wave oscillates between the boundaries and gives the appearance of a wave that travels only in horizontal direction, with a speed determined by the total amount of stability in the layer. (For every wave length a different speed is found.) The wave cannot penetrate into the unstable layers and is trapped in the stable layer, since its speed of propagation approaches infinity for zero stability. (Some energy is always leaking through the boundaries.) By this mechanism, a quick dissipation of the wave energy into the upper atmosphere or by the friction layer at the ground is avoided. The stable layer thus forms a "duct" in which the wave is "bounded."

Another problem is how long these waves live, whether they grow or die, and whether they are amplified or damped. This portion of the theory deals with the problem of "dynamic stability" and is, by far, more complicated than the first part. It is the true nucleus of the theoretical problem and will be discussed later in a separate paper.

Does the jet stream form a "duct" in a certain layer of the atmosphere? The analysis of several jet-stream cross sections, which Riehl and Newton, of Chicago University, were kind enough to loan to the author, gave exactly this result. (Complete cross sections through the jet stream are rather rare.) I have already mentioned that one of the characteristic properties of the jet stream is a strong positive wind-shear zone in the middle troposphere and an even stronger negative shear in the substratosphere. Fig. 6 shows in the left part a cross section through a jet stream over Lerwick, Shetlands. Plotted are the wind velocity $\bar{u}$ and the (potential) temperature θ against altitude. The tropopause is apparently near 9 km. (30,000 ft.). One can see the strong curvature of the wind profile at 5 km. and 10 km. altitude. On the right side of the picture, the stability term, or rather the square root of the total stability, is plotted against altitude. The vertically hatched area is the duct bounded above and below by the diagonally hatched layers. The latter indicate the unstable layers produced by the two shear zones. The curves vary slightly for different wave lengths, but the position of the duct remains essentially the same.

In the right half of the picture, the square root of the stability K is defined. It is composed of the three terms described: (1) the thermal stability, (2) the change of wind shear with height, and (3) the influence of the wave length. (Note that $\beta = \theta'/\theta$, where the prime denotes differentiation with respect to height, θ = potential temperature, g = gravity, $\bar{u}$ = wind velocity, and c = wave speed with respect to ground. α is the wave number that is proportional to the reciprocal of the wave length.) All three terms are of comparable magnitude. The shape of the duct varies slightly with the wave speed. Fig. 6 shows an example for $c = 0$. Fig. 7 (right half) shows three examples for wave speeds, $c = 0$, 10, and 20 m. per sec. At the latter speed, the duct splits into two halves with an unstable layer in between (hatched area).

The propagation velocity or phase speed of the waves can be calculated by integrating the stability term K over the height of the duct. This integral has to have a certain value (approximately $\pi/2$ for the fundamental mode), which follows from the so-called "phase integral method." Thus, every wave length corresponds to a certain propagation speed. (This is our dispersion equation and represents an eigenvalue problem.)

Fig. 7 shows, in the left part, the relation between wave length λ and wave speed c for two different examples of a jet stream in Europe (Lerwick, Shetlands, and Aldergrove, Ireland). Also the period τ of the waves is noted in the picture. One sees that it agrees with the range of periods observed in the microbarographic waves and the oscillations encountered in the sail-

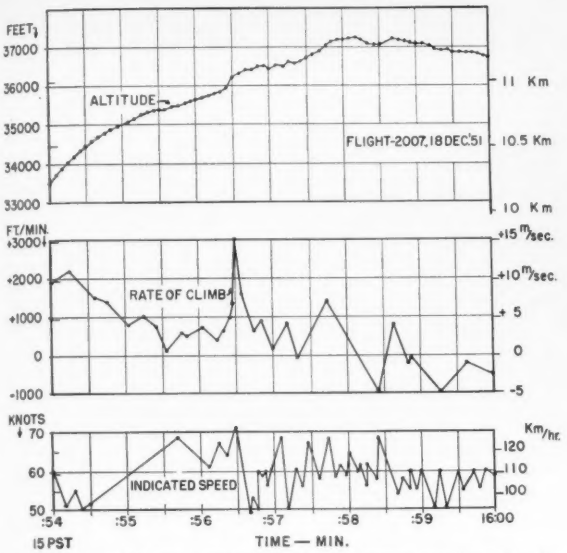


FIG. 8. High-level turbulence in the upper portion of a jet stream as measured by research glider Pratt-Read of Mountain Wave Project on December 18, 1951. Pilot, L. Edgar; copilot, J. Kuettner.

FIG. 9. Stationary wave cloud with high-level turbulence in the jet stream. This picture was taken by R. Symons from Bishop, Calif., at the same time the measurements of Fig. 8 were made. Lower center shows dark roll cloud. High wave clouds at 39,000 ft. Sierra Nevada on right side. Wind from right to left.

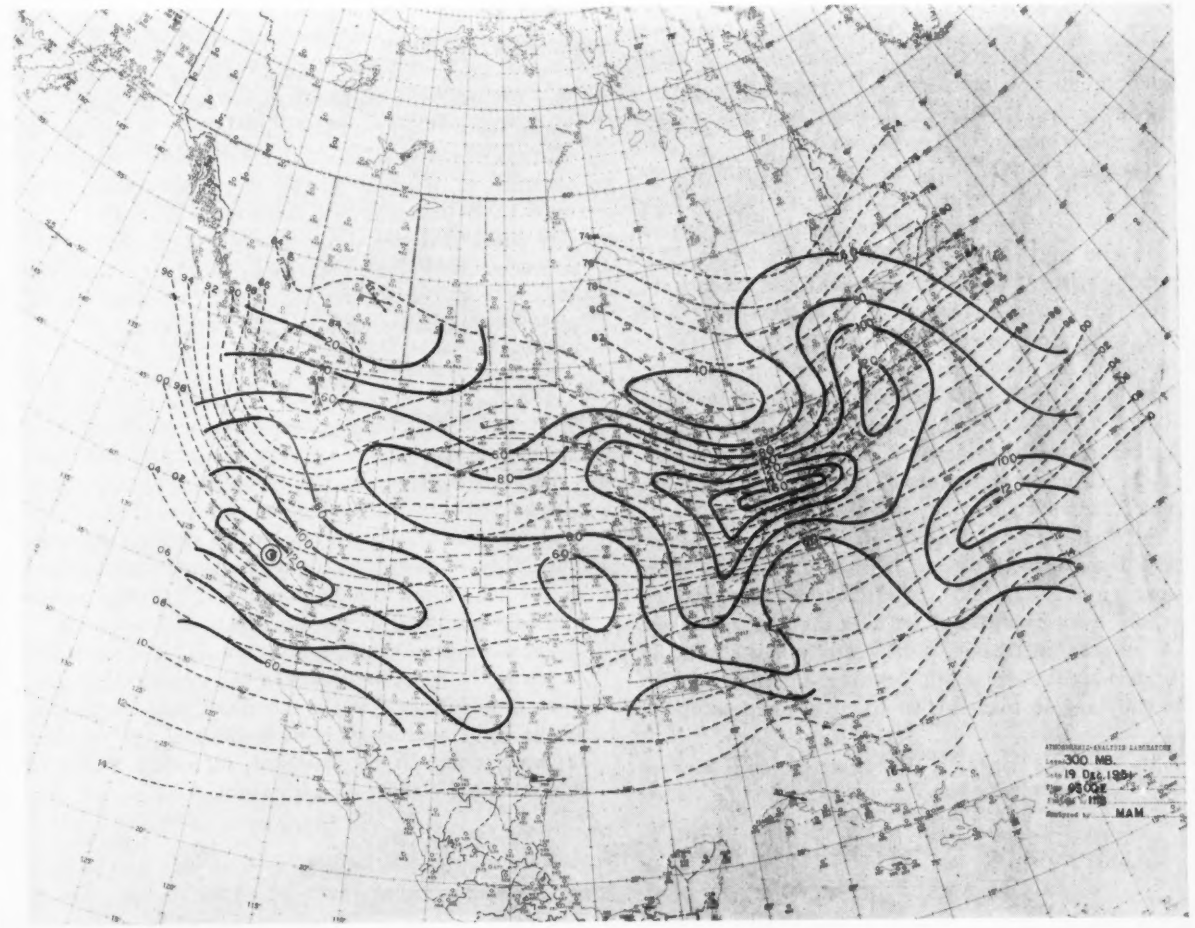


FIG. 10. Weather map of the 300-mb. (30,000-ft.) level, December 19, 1951; 03:00 world time (equals December 18, 19:00 PST). Dashed lines are height of 300-mb. surface (00 = 30,000 ft.; 92 = 29,200 ft.). Solid lines are isolines of wind velocity in knots.

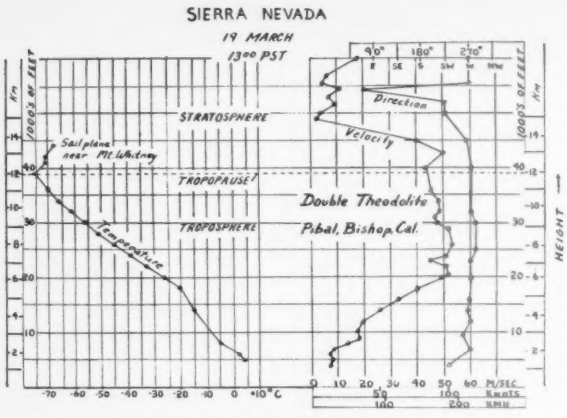


FIG. 11. Aerological conditions on March 19, 1952, over Sierra Nevada. *Left side*, temperature vs. altitude measured by sailplane Pratt-Read up to 44,600 ft. (world altitude record). Tropopause at 39,000 ft. Pilot, L. Edgar; copilot, H. Klieforth. *Right side*, velocity and direction of wind as measured by double theodolites up to 60,000 ft. over Bishop, Calif.

plane. However, since the method used here gives only an approximate solution, no emphasis is put on the numerical result. v denotes the group velocity for Lerwick with respect to ground. (With respect to air, the group velocity is smaller than the phase velocity.) The slope of this curve and some other considerations indicate that the preferred wave length lies at higher phase speeds. However, the speed is limited by the fact that the duct tends to split at high wave speeds into two halves of insufficient size.*

It seems that the favorable wind profile is not found in the whole jet stream but only in certain sections, especially near the lateral boundary of the jet stream north and south of the core of a westerly jet. The question arises as to how the air behaves in the unstable layers. If convection starts there, it seems that some kind of a stratospheric "thermal flight" should be possible in the upper part of the jet stream. Actually, it would not be thermal convection but large-scale turbulence. This brings up immediately the question of whether we have here an explanation for the so-called "clear air turbulence," which is encountered under jet stream conditions near the tropopause.

Fig. 8 shows what happens if one flies into the unstable layer of the jet stream with a sailplane. On the afternoon of December 18, 1951, Larry Edgar and the author, in a two-seater glider over the Sierra Nevada, ran into an increasing northwesterly jet stream of approximately 140 m.p.h. Strong updrafts carried the sailplane to over 40,000 ft. at a temperature of −90°F. Between 34,000 and 39,000 ft., severe turbulence was encountered, which endangered the structure of the plane. Accelerations up to +4 g and −2 g were measured. At 36,000 ft., the updraft temporarily reached 3,000 ft. per min. Fig. 8 shows an evaluation of 6 min. of film taken of the instrument panel in the glider. During a $1^1/_2$ min. period, the rate of climb at 37,000 ft. changed from 1,400 ft. per min. climb, to 1,000 ft. per min. descent, to 800 ft. per min. climb, and again to 1,000 ft. per min. sink. In the final descent, the glider had to be flown at almost 90 knots indicated speed, which corresponds to approximately 170 m.p.h. true speed, in order to make progress against the wind in the direction of the airport.

With spoilers "full open," a rate of climb of almo 1,000 ft. per min. was encountered at 32,000 ft. altitude. This corresponds to a vertical motion of the air of over 4,000 ft. per min. (20 m. per sec.). In the forenoon of this day, the pilots of the Sierra Wave Project, Parker and Robinson, flew the sailplane to over 42,(ft. Lapse-time motion pictures of the high lenticu cloud taken at this time show large wave-like turbulence elements rolling through the standing wave cloud, which present the picture of a wildly surging ocean. (See Fig. 9.) Fig. 10 shows the upper-air map about 3 hours after this flight. The jet-stream analysis was made by our Atmospheric Analysis Laboratory in Cambridge, Mass. The jet stream lies directly over the flight area (circle). On March 19, 1952, Larry Edgar and Herald Klieforth reached an altitude of 44,600 ft. in a sailplane without the slightest turbulence. The air at this level was still rising at over 1,000 ft. per min. The wind soundings of that day show that the drop of wind speed occurred at altitudes above 45,000 ft. (Fig. 11). It is conceivable that a zone of severe high-level turbulence would have been encountered at the 50,000-ft. level.

CONCLUSION

Of course, it must be realized that the combination of a standing mountain wave with a jet stream cannot be generalized. However, the turbulent convection currents near the tropopause exceed the usual thermal convection in the lower troposphere so strongly that the possibility of sailplane flights in the unstable layer of the jet stream can be considered. Whether pilot and ship can stand such a strain is another question.

Far more comfortable soaring would be encountered by using the traveling waves in the smooth jet-stream duct, provided those waves are of sufficient magnitude. If the right equipment is available and the problem of navigation can be mastered, motorless flights of more than 1,000 miles appear possible.

* The integrated stability of each of the two ducts does not reach the necessary value of $\pi/2$.

Flexural Fatigue Strength of Anodized 24ST Aluminum-Alloy Sheet

CHARLES B. CLIETT*
Mississippi State College

SUMMARY

The results of an investigation to determine the effect of anodizing on the flexural fatigue strength of 24ST aluminum-alloy sheet are presented. The conclusion drawn is that anodizing reduces the life of the aluminum alloy when subjected to fatigue conditions and when subjected to the combined action of corrosion and fatigue.

INTRODUCTION

THE DEVELOPMENT of high-strength aluminum alloys that have a less than proportional increase in fatigue strength has brought to the forefront the seriousness of fatigue. Although aircraft structures that fail because of engineers' lack of understanding of fatigue phenomena have been few in number, this number has been steadily increasing.

Anodizing has been used to a large extent in the aircraft industry to aid in combating corrosion, another serious hazard to the continued high-strength efficiency of structural aluminum parts. The aluminum-hydroxide surface produced has good corrosion resistance and provides an excellent bond for paint. The two most important solutions used for anodizing are chromic acid and sulphuric acid. Generally, for aluminum alloys containing 5 per cent or less copper, chromic acid is used, and, for greater than 5 per cent copper, sulphuric acid is used. If the chromic-acid solution is used on alloys containing greater than 5 per cent copper, the electrolyte is destroyed; therefore, its use must be limited to alloys of lower copper content. The sulphuric-acid solution has no such limitation and has been used for alloys having a copper content above and below this figure. All future references to anodized specimens must be confined to the sulphuric-acid bath method, since all specimens tested were prepared in this manner.

This article is a report on a series of tests to determine the flexure-fatigue characteristics of anodized aluminum alloy, and an effort has been made to compare these characteristics with those of the virgin aluminum alloy.

INVESTIGATION OF FLEXURE-FATIGUE CHARACTERISTICS

In the tests, the characteristics involved are fatigue and corrosion-fatigue. Corrosion-fatigue is not to be confused with the more familiar expression, stress-corrosion. Stress-corrosion normally is used to refer to the effect of a corrosive atmosphere in the presence of a relatively constant stress. Corrosion-fatigue is the combined action of a corrosive environment and cyclic stress. The corrosive atmosphere used was created by allowing plain tap water to drop slowly upon an extremely lightweight wick in contact with the test specimen. Through this arrangement, a small amount of water was in contact with the test section during the entire loading procedure.

All tests were conducted on the Sonntag Flexure Fatigue Machine, Model SF-2.[1] The machine produces completely reversed cycles of stress at the rate of 1,800 cycles per min.

The material used in this investigation was the standard 24ST Army-Navy Specification AN-A-12 aluminum alloy. All specimens were cut from one sheet, of nominal thickness 0.040 in., parallel to the direction of rolling, for this factor alone has appreciable effect on fatigue properties.[2]

A sketch of the specimens used in this investigation is shown in Fig. 1. Specimens were produced by use of a

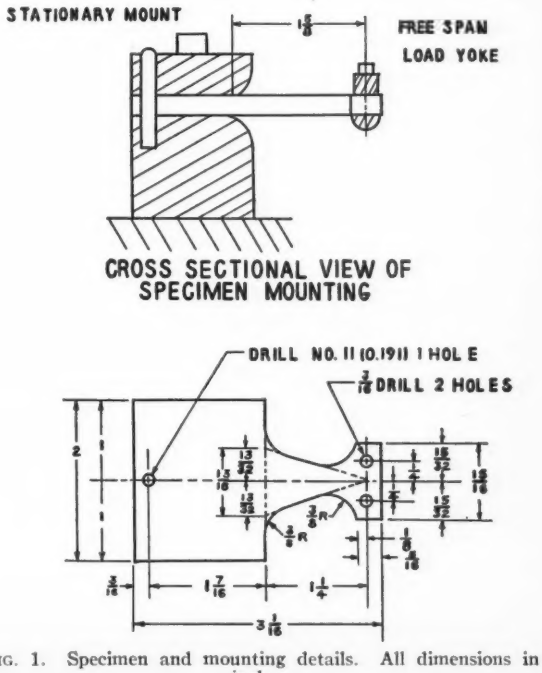


FIG. 1. Specimen and mounting details. All dimensions in inches.

* Assistant Professor, Aeronautical Engineering Department.

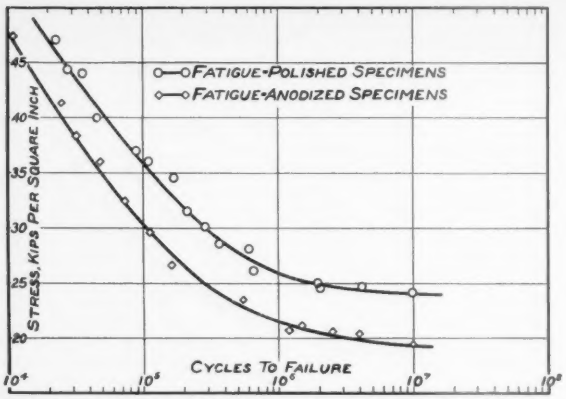


FIG. 2. Comparison of the fatigue flexure strengths for polished 24ST sheet and anodized 24ST sheet.

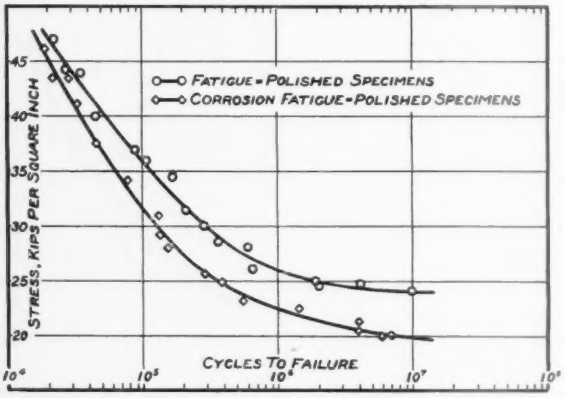


FIG. 3. Comparison of fatigue and corrosion-fatigue flexure strengths for 24ST polished sheet.

jig. They were cut to size with a router and were then polished to remove all surface scratches and tooth marks of the router. After the polishing, a portion of the specimens produced was anodized commercially by the Southern Aluminum Finishing Company, of Atlanta, Ga. The procedure they used follows. The specimens were cleaned in a hot caustic-soda bath. They were then immersed in a 15 per cent sulphuric-acid bath at 70°F. for the anodizing process. After completion, the specimens were sealed in water at 185°F. Some of the specimens were tested in this condition for fatigue characteristics. After being coated with a paint surface, which consisted of a zinc-chromate primer and normal finishing of Preparakote, followed by Duco lacquer, additional anodized specimens were subjected to corrosion-fatigue conditions.

The serious detrimental effects of the anodizing process can be seen in Fig. 2. Simple flexure-fatigue strengths of polished specimens are compared with those that were polished and then anodized. For a given applied stress of 30,000 lb. per sq. in., the life expectancy of an anodized specimen is about 110,000 cycles; for a polished specimen, it is nearly 290,000 cycles. This represents a reduction in life expectancy of 62 per cent. If stressed to 25,000 lb. per sq. in., the reduction in efficiency is 80 per cent.

When an anodized specimen was viewed under a microscope, it was found that its entire surface was pitted and, thus, susceptible to the formation of fatigue cracks. It seems reasonable to conclude that the etching of the metal, which occurs in any form of anodizing, would be sufficient to make the use of anodized materials impractical in areas subject to fatigue.

A study of the corrosion-fatigue characteristics of the aluminum alloy is shown in Fig. 3, where a comparison is made from tests on polished specimens under fatigue and corrosion-fatigue conditions. As shown, this effect is present throughout the range of testing. Results from investigations on steel and other ferrous alloys show a similar effect for low values of stress but show no effect of the corrosive atmosphere at high values of stress.[3] The high rate of a corrosive action on aluminum, once its protective film is broken, is the only theory presented as an explanation of this fact. The corrosive action produced by mercury when in contact with aluminum is a good example. If aluminum's protective film is not broken, no action occurs. However, if the film is broken, the mercury amalgamates with the aluminum and rapidly corrodes it.

Study under a microscope reveals that a fatigue failure produces a break similar in appearance to a tension failure, with the exception of the portion of the cross section where the inital crack formed. In this area the fracture is smooth and glassy in appearance. Generally, the crack that eventually leads to failure is the only rupture in the total test section. Such is not the case when a corrosive environment is present in conjunction with the fluctuating stress. Under these conditions, the entire test area is affected. Many cracks are produced, any one of which will eventually lead to ultimate failure if an earlier rupture does not occur elsewhere. When anodized specimens that had been subjected only to fatigue conditions were viewed, an intermediate condition was found to have occurred. Often more than one crack had started but never a large number.

Fig. 4 compares the corrosion-fatigue strength of specimens that have been anodized and painted with

(*Concluded on page 42*)

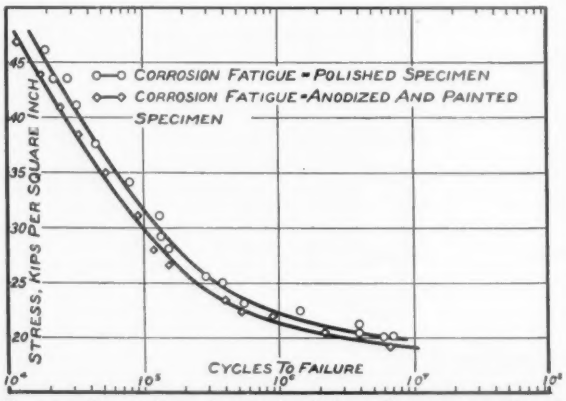

CORROSION FATIGUE-POLISHED SPECIMEN
CORROSION FATIGUE-ANODIZED AND PAINTED SPECIMEN
STRESS, KIPS PER SQUARE INCH
CYCLES TO FAILURE

FIG. 4. Comparison of corrosion-fatigue flexure strengths of polished 24ST sheet and anodized and painted 24ST sheet.

Guest Editorial by Dr. Jerome C. Hunsaker

(*Concluded from page 21*)

permanent due to physical laws or temporary due to the current state of technology.

Consideration of the power needed for very high speed shows that there is a physical limitation to the speed of the conventional airplane due to the compressibility of the air. Near the speed of sound, the air offers greatly increased resistance. It fails to move aside as the airplane advances. Shock or compression waves are formed which may destroy the smooth flow over the wings, changing the aerodynamic forces in magnitude and distribution. As a result, the airplane may become unbalanced and out of control, or it may disintegrate under severe buffeting.

One can say, from what is known now, that conventional airplanes with piston engines are limited for practical use to speeds well below the speed of sound. The piston engine has not enough power to push to such a speed, and the conventional airplane could not be flown there even if enough power were applied.

Actually, there is no absolute sonic barrier. Jet propulsion can give power enough, and modern aerodynamic research has shown how to shape wings and bodies to be flown safely through the sonic range of speeds and into the supersonic. Here we have an answer to the question as to the relative precedence of research and bold experiment. Bold experimenters might have tried for supersonic flight as soon as jet propulsion was available, but they would not have survived enough experiments to learn from their experience. Without the guidance of aerodynamic research, supersonic flight would not have been achieved experimentally today.

I believe that there is good reason to expect that technological progress based on applied mechanics will continue to improve the airplane for use in either peace or war. . . .

Aeronautics can be a tool for the implementation of a world-wide régime of law and order. It facilitates the meetings of statesmen, the conduct of inspections, and police action and, in general, can serve for both surveillance and enforcement.

Professor Ogburn has said that historians are reluctant to give credit to technology rather than to great men as a social force, while philosophers of history give all credit to ideas. Neither party can be entirely right.

Columbus discovered America and set in train a vast succession of social changes, but back of Columbus lay the technology of the ocean-going ship. Without Columbus some other European would have discovered the New World. The existence of the ship guaranteed it.

There is a propelling force in technology which drives great men and also constitutes the propelling force of ideas. For example, the idea of nationalism is powerful today. The territorial base for the modern state was laid by transportation inventions and consolidated by communications. Without them nationalism would be restricted to a small area. Finally, the present international struggle, which is only accentuated nationalism, is based on the inventions of warfare, principally air power. Technology prepares the way for statesmen or for conquerors.

There is now a huge disproportion between human wisdom and human power. Perhaps the best fruits of the tree of knowledge are tools. The airplane of the Wright brothers has become the vehicle for a world-wide system of air transportation, and at the same time, it has been the means for the annihilation of cities.

There have been sermons on the good and the evil of new knowledge, and the dedicated research man is not unaware of the perils of his success. The airplane is just another tool to serve the purposes of mankind; whether for good or evil is determined by the user. The individual with an airplane is not a serious menace since he is controlled by the police power of the state. So is the individual with a torch or a motor car. The complex apparatus of air power, however, is a tool of the state, to be used as its leaders may desire. In them we hope for wisdom.

Complex societies are expected to produce social patterns capable of absorbing innovations. Our present international society is in the process of adjusting itself to the innovation of flight. The adjustment is painful, and the final pattern has not yet evolved.

In scientific research we have a kind of chain reaction. Research emits new knowledge whose applications confront us with new problems. These problems in turn excite new research, with further new and perhaps unexpected results. The evolution of aeronautics has proceeded in this way on a wide front, and we may expect it to continue at an even more rapid rate.

One may well expect that the effects of the advancing technology of flight will be substantial, with a consequent disturbance of the relatively static distribution of man and his works over the earth, as determined primarily by physical geography.

Geography has hitherto compartmented peoples in accordance with the physical features of land and sea, by climate zones, and by cultural frontiers. Now we have mobility in a third dimension with which to reckon. The ocean of air provides highways from anywhere to everywhere. Geographical barriers, largely determined by older modes of transportation, are becoming unreal; they no longer give security or prevent the interpenetration of ideas. An iron curtain is an artificial and socially expensive attempt to maintain a geographical status more appropriate to a previous century.

Flight Testing and Operational Problems of an AFTERBURNER-EQUIPPED TURBOJET INSTALLATION

R. R. TEMPLETON*

North American Aviation, Inc.

Introduction

The modern aircraft power-plant installation represents one of the most difficult series of compromises which any group of engineers is called upon to make in the attempt to reconcile the many conflicting objectives of an aircraft propulsion system. The forceful competition in the aviation industry and, even more important, among nations of differing ideologies requires that every effort be exerted to achieve precisely the right balance in the final compromises made in all new aircraft. Weight reduction must be gained without too great a sacrifice of reliability. Maximum power must be achieved without excessive fuel consumption. The cooling of engine, equipment, and basic structure must be accomplished with minimum attendant aerodynamic drag or thrust losses resulting from engine air extraction.

In this age of performance refinements and transonic speeds, automatic controls are becoming mandatory. Being only mortal, the pilot cannot match the precision control of the black boxes. Also, the many new demands upon his time now place a high premium on automatic controls for the entire power plant and allied systems. The need for tremendous amounts of power is creating new engine types whose control is no longer either safe or efficient if extensive manual monitoring is required. Here again, the need for automatic devices is indicated. However, complexity of high order inevitably accompanies the use of automatic controls. This complexity can easily compromise the first-order reliability so necessary in a heavier-than-air machine. Any amateur mechanic who has struggled with an automatic washing machine can testify to the truth of this statement.

The new problems resulting from the installation of advanced power plants in modern military aircraft may be illustrated by consideration of a high-performance fighter-type airplane, the North American F-86D interceptor, employing the General Electric J47-17 turbojet engine with an afterburner (Fig. 1). The engineering development of such a power-plant installation comes to its climax during the flight testing and early phases of evaluation experience.

Presented at the Propulsion Session, Annual Summer Meeting, I. A. S., Los Angeles, July 16–18, 1952.

* Test Engineer, Power Plant Section.

The F-86D Interceptor

The Sabre "D" is superficially distinguished from its F-86 relatives by its radar nose and the larger aft fuselage required to house the afterburner. The real differences are more fundamental. The F-86D is an all-weather interceptor whose speed, rate of climb, and altitude range are comparable to, or beyond that of, any American interceptor of its type now in production (Fig. 2). It is also distinctive in that it is single-place.

In combat, the F-86D will be initially directed toward its target by ground radar. When the target is sighted on its own radar screen, the airplane's electronic devices displace ground radar and guide the Sabre "D" to its target. Twenty-four rockets, each capable of downing the largest bomber, are fired in carefully worked-out salvos. To accomplish this task, the F-86D carries more electronic gear than a World War II heavy bomber.

Great effort has been made to provide for the efficiency and comfort of the pilot. Surface controls are

Fig. 1.

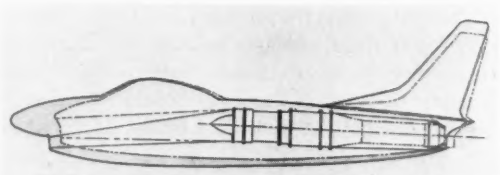


Fig. 2. Increase in size of F-86D over F-86A.

power boosted. An air-conditioning system pressurizes and heats or cools the cockpit. The all-weather function of this interceptor necessitated incorporation of heated-surface anti-icing systems for wings, empennage, windshield, various air inlet leading edges, and the jet-engine inlet air vanes.

Unique in the Sabre "D" is the completely automatic electronic power control provided with the engine (Fig. 3). Integrated control of engine, afterburner, and variable-area nozzle is achieved by the pilot merely by positioning the throttle to the desired thrust setting. The electronic control does the rest of the work, infinitely better and faster than any human, by regulating fuel flow for best performance throughout all combinations of speed, altitude, engine r.p.m., temperature, and engine airflow.

Basically, the electronic control for engine and afterburner systems consists of a single cockpit lever; several sensing devices that translate temperatures, r.p.m., and similar information into electrical values; and two electronic computers that "digest" the signals from the sensing devices. The digestion process is almost instantaneous. The computers compare the power need, as selected by the throttle, with the engine's performance. If there is any difference between the two, the computers compensate accordingly by changing the settings of either the fuel valves or the variable-area nozzle on the tailpipe or both. This is accomplished by amplifiers that transform the signals from the computers into usable power levels that actuate electric motors.

Built into the computers are electronic limiting circuits that make it impossible for the pilot or flight conditions to exceed limiting engine temperatures, accelerations, r.p.m., and fuel flow. The pilot cannot override these built-in electronic safety limits.

The use of an afterburner on the Sabre "D" is not unique, since there are numerous other afterburner installations in successful use (Fig. 4). However, the incorporation of the variable-area discharge nozzle on the J47 engine permits greater utilization of the benefits inherent in an engine and afterburner combination. Optimum control of this type nozzle dictates the use of a system that electrically integrates all main engine and afterburner operating variables into a fully automatic control system. Thus, the continually changing fuel and jet nozzle adjustments are made with a degree of efficiency which is beyond the ability of the best pilot. It is only natural that a major portion of the power-plant development and flight-testing effort should be absorbed by the electronic control and advanced afterburner in the F-86D propulsion system. The implications of these two innovations will be my primary concern.

Electronic Control System Problems

A great controversy has raged for at least the past 5 years regarding the practicability of an all-electronic primary engine control. The electronic tube is viewed

Fig. 3.

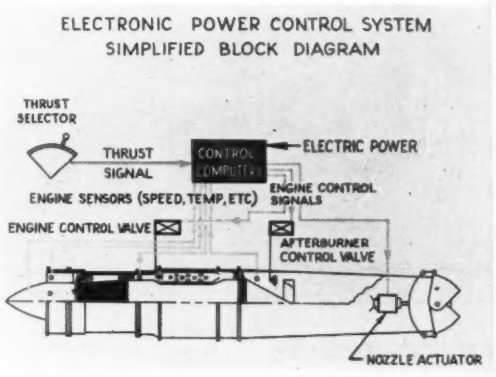


Fig. 4.

with great suspicion by many power-plant engineer and even by electronic engineers. Their attitud is expressed in a statement made some time ago b an officer at Wright-Patterson Air Force Base. In discussing the extensive use of electronic techniques and their susceptibility to trouble due to temperature, humidity, altitude, and vibration as found in aircraft installations, he said, "The principal, but by no means the only, culprit is the vacuum tube." The experience obtained to date with the F-86D electronic engine control indicates that major improvement in tube reliability has been achieved; however, emphasis is now required in an entirely different area of the electronic application. A comparison of the P-51 Mustang and the F-86D electrical systems (Fig. 5) shows that the former has 515 individual wires and the latter 5,500 wires totaling $4^1/_8$ miles of wiring or 15 times as much as that of the average home. In the words of J. H. Kindelberger, Chairman of the Board at North American Aviation, Inc., each of these wires joins one source of trouble with another potential source of trouble, *but it is so small and so simple a thing as the routing and joining of two wires* which, in our present experience, constitutes a major weakness of an electrical system intended for use as a primary

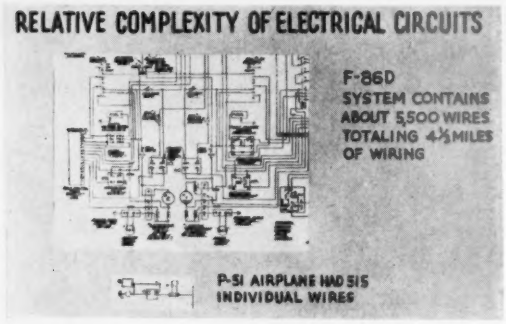


FIG. 5.

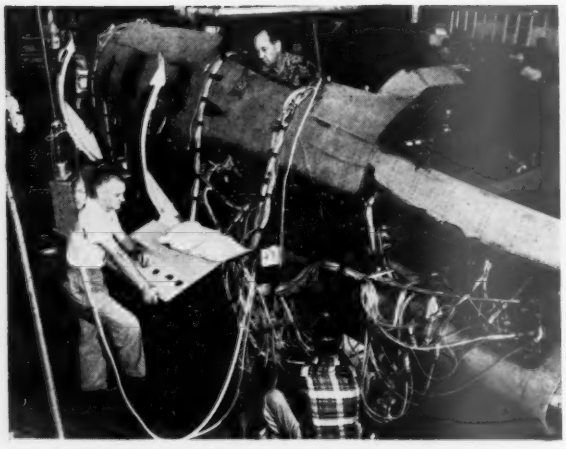


FIG. 6.

power control of any type. The aircraft and engine industries as a whole have concentrated great effort and expense on the various components of electronic systems but have not placed proper emphasis upon the need for maintaining the utmost integrity of the simple electrical conductor and its many simple junctions. Commercial air lines, too, have recently had occasion to learn this the hard way. Failures of such components as vacuum tubes, resistors, and transformers do occur occasionally but represent a hazard that has been minimized by fail-safe circuit design. In contrast, it has required many hours of costly, time-consuming flight testing to prove the necessity for extreme care in the mechanical design, the fabrication, the assembly, and the maintenance work on electrical leads and connections in the airplane and on the engine equipment (Fig. 6). In its very simplicity, the electrical connection of a wire creates a hidden mental hazard for all who deal with the problem. And, once a carelessly made or poorly designed connection is buried in the maze of tightly packed equipment in a modern fighter, it may become a devilish device that misbehaves only occasionally and defies detection by every means short of complete removal of the system wiring in question. Use of carefully selected connector types or even the design of new connectors, specifically adapted to the particular environment and application is certainly warranted. There is little merit in adhering to standardized types if reliability is sacrificed appreciably on engine or essential airplane systems. You may then ask: Why not also provide parallel wiring for important systems? The answer is that the weight and space requirements become prohibitive, sacrificing the very virtues that may make electronic systems superior to others. A better solution at this stage in the development of an automatic fuel and engine control system is the use of an emergency mechanical control of the simplest possible nature, permitting the pilot to get home safely in an emergency. At some future date when the present human inadequacies of technical knowledge and electrical skills have been eliminated from the electromechanical systems upon which a pilot must depend, *all* emergency devices can be eliminated, but that day has not yet arrived.

Any discussion of automatic engine controls recalls the long-cherished wish of power-plant engineers for a single-lever control with a linear relationship of motion to power output. This has been substantially achieved in the F-86D (Fig. 7a). It has come as somewhat of a surprise to realize belatedly that this reciprocating-engine goal has little appeal to the jet pilot. He finds that both maximum range and maximum power settings are confined to high-power operation. Accordingly, the entire middle range of a linear throttle has little usefulness for jet-engine control and should be scheduled to favor more sensitivity over the high-power range actually used in flight.

Electronic Cooling Problems

The need for electrical power-generating equipment of first-order reliability, in connection with electronic primary controls, is axiomatic. However, the extremes of speed and altitude now encountered in modern interceptors have brought nightmares to those charged with the responsibility for cooling electrical components of any type in such airplanes (Fig. 7b). The need for electronic equipment cooling has been recognized by some for the past several years, but only recently have definite results been obtained in this direction. The Korean War has demonstrated beyond all argument that, for example, most inverters procured to existing

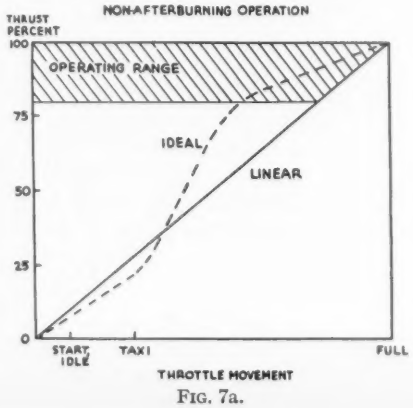


FIG. 7a.

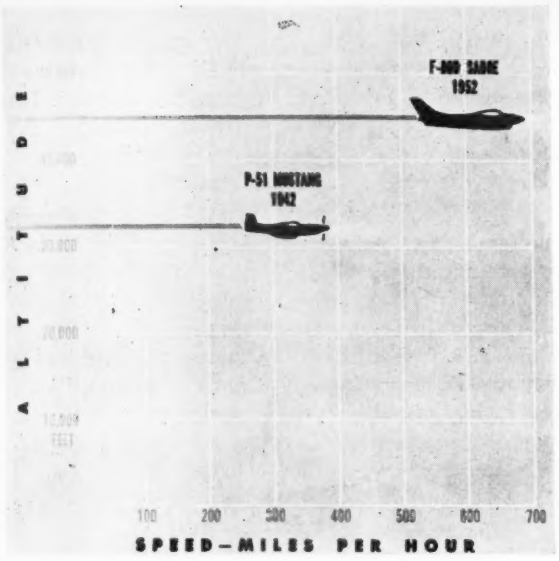


FIG. 7b.

specifications are obsolete, as are the specifications themselves. Electrical components suitable for living-room radios have little chance for survival in airplane ambient temperatures that, at Mach 1, can be close to 213°F. Yet much of the currently available equipment is procured to specifications that require satisfactory operation up to only 160°F. ambient maximum temperature and up to 35,000 ft. maximum altitude.

It is difficult to grasp the magnitude of electrical cooling problems without comparisons (Fig. 8). The typical contemporary single-place interceptor has a power-generating capacity of approximately 32,000 watts, an increase of more than 1,000 per cent over comparable World War II airplanes or more than 250 per cent over the F-86A Sabre Jet. This power is fed through approximately 5 miles of wire to hundreds of vacuum tubes, motors, light, actuators, etc. Radar equipment alone may contain more than 6,000 coils, condensers, and resistors. Obviously, all this equipment and the associated power-generating u nits produce heat loads that must be dissipated. It is commonly assumed that the abundant free air can be employed to effect this cooling. This becomes a difficult assignment, since the so-called "free" air becomes extremely costly in drag, and no one yet has designed a *simple* system to use 213°F. ambient air at Mach 1 to cool heat-producing equipment to 160°F. It would be possible to bleed more air from the jet engine and run a refrigeration unit to cool the electronic equipment. The resulting thrust, weight, and space penalties become severe, although perhaps these are penalties we must pay if our electrical devices in tomorrow's supersonic aircraft are to function rather than overheat. It is considered that, for the present, we have reached the economical limit of robbing thrust from the engine through compressor bleed and that other solutions must be forthcoming (Fig. 9). By the use of new or better high-temperature materials and sound thermodynamic design, we have two approaches that will greatly assist in solving this electronic cooling problem. Above all, we now have an awareness of these problems by all concerned—a realization that a faulty inverter, for example, can transform a $500,000 interceptor into a useless "hangar queen."

INSTRUMENTATION

The problems of flight testing all this equipment in a single-seater interceptor are exceptionally complex. Recording equipment of sufficient compactness simply cannot be procured; it must be designed and constructed. Space must often be achieved with such trickery as the use of mirrors to obtain the necessary focal lengths required by recording cameras. The demands made by contemporary test procedures far exceed the capacities of conventional instrumentation. For example, during World War II, our best equipment could record temperatures at the rate of perhaps one point each 2 sec. In the F-86D, we currently record 192 different temperature points in 24 sec.—a rate of 8 different points per sec. This rate can be significantly increased if necessary. On a current Sabre "D" test vehicle, a single hour's test flight can produce 128,000 separate data points, assuming that we record data each half second. Frequently, we are compelled to record data at 10 times this rate, which would, of course, give us 128,000 data points in 6 min. The time required

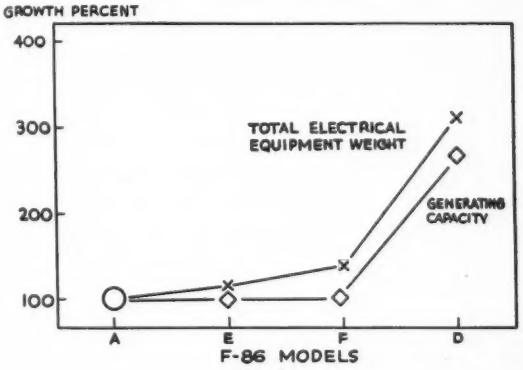


FIG. 8.

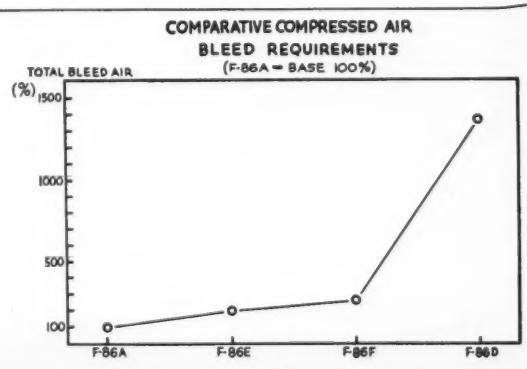


FIG. 9.

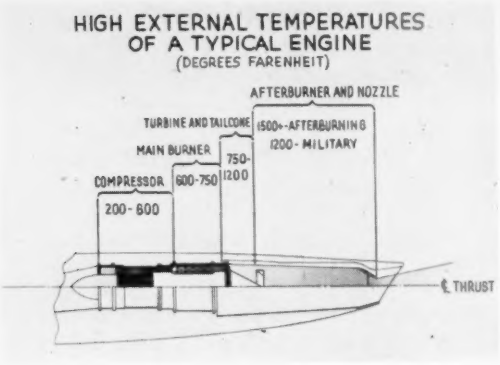


FIG. 10.

to transcribe, calibrate, and reduce to standard conditions such a mass of data is self-evident. Small wonder it is that obtaining answers to some of our problems is time-consuming in the extreme.

STRUCTURAL COOLING

Much attention has been devoted, during the flight-test phase and initial operating period on the F-86D, to the structural cooling problem incurred by the use of an afterburner (Fig. 10). The large number of temperature measurements necessary are attributable in part to the studies required to achieve an aerodynamically and structurally efficient mating of the fuselage with the high-temperature engine and afterburner tailpipe. A simple jet engine operates with a maximum tailpipe surface temperature of perhaps 1,200°F. However, the inherently larger tailpipe of an afterburner installation attains surface temperatures approaching 1,500°F. during afterburning. Since aerodynamic considerations require that the aft fuselage be wrapped as tightly as possible around this much hotter pipe, the problem of adequate structural cooling becomes a major headache. A conventional solution is the forced circulation of cooling air over the hot pipe surfaces (Fig. 11). In the F-86D, as in its F-86 predecessors, this cooling medium is employed successfully. However, the limitations of space between an overgrown tailpipe and the aerodynamically dictated aft fuselage create a squeeze play on the cooling passages available. In this respect, the use of the ejector pumping principle has been extremely effective but not without a lengthy and painful development program. The application of cooling jet ejector systems is full of pitfalls that must be carefully explored by every resource of laboratory and full-scale flight testing. The definite lack of basic research on ejector systems for the purpose in question can result in an initial design that will be far superior in its drag-producing qualities than in its effectiveness as a cooling air pump. The unwary are cautioned to approach this problem with every engineering tool at their command.

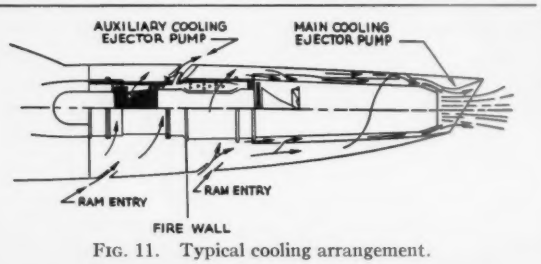


FIG. 11. Typical cooling arrangement.

As a means of measuring jet wake energy and pressure gradients, it is common to employ some form of pressure-measuring rake. The use of this device on an afterburner-equipped engine required development of a new instrument at North American. Temperature of afterburner gases may approach that of perfect combustion, approximating 3,200°F. Even with the best high-temperature-resistant materials available, the rake that was eventually adopted required internal forced-air cooling. This type of fixed rake, which projects into the exhaust wake, is only partly satisfactory. Further development of a traversing-type pressure probe is under way to refine flight measurements of thrust and jet-ejector performance criteria. (See Fig. 12.)

It is particularly true of afterburner installation that the key to good design lies in careful attention to metallurgical considerations (Fig. 13). Just when it seemed that the structural-cooling problem of the afterburner would force the general use of heavy steel components, metallurgists have given new hope in the form of the metal titanium. The extensive structural temperature surveys of the F-86D, with the use of specialized pyrometers specifically developed for this application, will form a useful background for the selective use of dural, steel, or titanium. Thus, the opportunity of tailoring metals to the different temperatures in each area of the fuselage affected by the afterburner will permit significant weight-savings.

The air-frame manufacturer is becoming increasingly burdened by the necessity for conducting costly and time-consuming development programs on numerous basic engine components, as well as on small accessory units. A certain amount of such testing is justified,

FIG. 12.

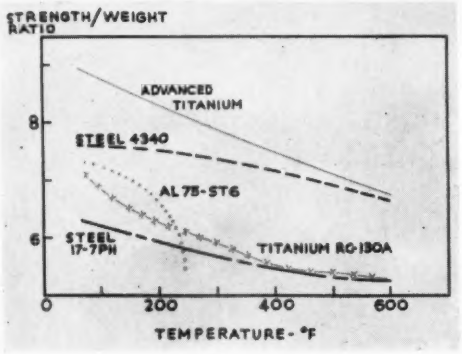


FIG. 13.

FIG. 14.

such as the final matching of time constants and performance evaluation beyond the range of flying test beds or laboratory testing. It seems apparent, however, that much of this development testing, with its present need for bulky instrumentation and repeated costly flights to evaluate each detail change, can, in the overall view, be more economically and efficiently accomplished in the development laboratory. I can assure you that the air-frame manufacturer is more than sufficiently harassed with his own system development problems.

CONCLUSION

In presenting this view of the problems confronting the power-plant development engineers, a word is in order in defense of the American military airplane and its design philosophy (Fig. 14). The complexity of modern military aircraft has frequently been criticized by proponents of the simple airplane. However, to perform the interceptor mission as presently conceived, air-borne electronics and the many systems for human safety and efficiency are essential. The record of the Sabre jet in Korea is proof that the best fighting machine is the one that achieves the best balance in the compromise between extreme simplicity and maximum consideration of pilot efficiency and safety.

The piloted airplane is here to stay for a while, and today's airplane with its automatic controls, computers, and radar is merely the forerunner of the guided missile that is mandatory to meet the demands of tomorrow. Present technical obstacles are but a foretaste of those we must overcome to achieve future air superiority.

From the power-plant engineer's standpoint, the challenge must be met by better utilizing the tools of electronics, fluid dynamics, thermodynamics, metallurgy, and basic physics. He must, through the assistance of governmental research agencies and the increasingly available knowledge of technically trained specialists, employ the best laboratory equipment, personnel and techniques obtainable. Only then can he conquer the tremendous technical problems confronting us in the race for air supremacy.

Plan Now to Attend

Twenty-First Annual Meeting

I.A.S., New York, January 26–30, 1953

A Miniature Supersonic Wind Tunnel

By Patrick W. Powers†

Summary

The design and construction of a miniature supersonic wind tunnel and schlieren flow observation system (Fig. 1) have been presented. This device permits visual and photographic observation of flow phenomena on extremely small objects (Fig. 2) and is particularly useful as a mobile demonstration unit and training aid. Total cost for the model constructed was less than $50.

The basic plan for construction is centered around the ease of fabrication of the tunnel nozzle and walls from plexiglas. The design of the test section is obtained from a series of graphs that allow for a wide range of air-supply pressures.

Symbols

cfm	=	cu.ft. per min.
p	=	pressure, lbs. per sq.in.
psia	=	lbs. per sq.in., absolute
psig	=	lbs. per sq. in., gage
A	=	area, sq.ft. or sq.in.
°F.	=	deg., F.
M	=	Mach Number, dimensionless
V	=	velocity, ft. per sec.
ρ	=	density, lb.-sec.^{2} per ft.^{4}
*	=	values at the throat (superscript)
t	=	stagnation or total values (subscript)

Introduction

Supersonic wind tunnels are usually complicated devices that require precision design and expensive construction. It is the purpose of this paper to outline the details for construction of a miniature supersonic wind tunnel from a standard pattern that allows for a wide range of air-supply pressures. In this case, miniature can mean a throat area of 0.0077 sq.in. The materials used are readily available and the fabrication techniques extremely simple. The complete wind tunnel with schlieren observation system is shown in Fig. 1. By ducting high-pressure air through a properly designed plexiglas test section, supersonic flow is obtained on small models as in Fig. 2. The model in this case is a 3-in. nail with a wedge point. Two unique features of the wind tunnel are an adjustable throat and the elimination of the walls of the test section. The schlieren flow observation system has been reduced to an intense light source and two ordinary magnifying lenses. It might be noted here that the small size of the test section restricts the research application of the unit.

† Captain, U.S. Army, Guided Missile Department, T.A.S., Ft. Bliss, Tex.

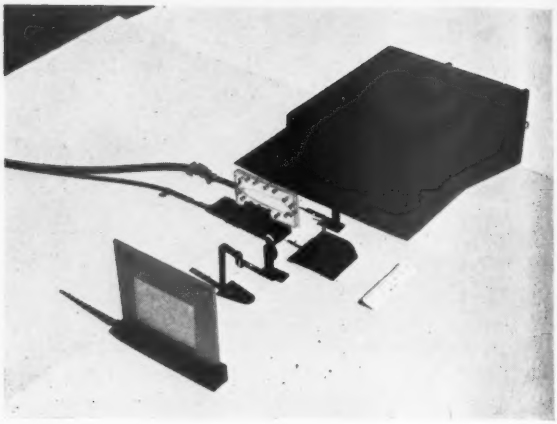


Fig. 1. Miniature supersonic wind tunnel and schlieren light system.

The design and construction of this wind tunnel are covered in the sections that follow.

Theory of Operation

The design of the supersonic nozzle is based on the conventional equations for steady, compressible flow. The following assumptions were made: (1) the stagnation temperature in the air-supply reservoir is between 60° and 80°F.; (2) the overall stagnation pressure ratio loss is 0.4; and (3) no boundary layer exists in the test section.

Starting with the equation for the conservation of mass,

$$\rho_t A_t V_t = \rho^* A^* V^*$$

and making the proper substitutions results in

$$A^* = \text{cfm}/272, \text{ sq.in.}$$

This relationship is plotted in Fig. 3. Figs. 4 and 5

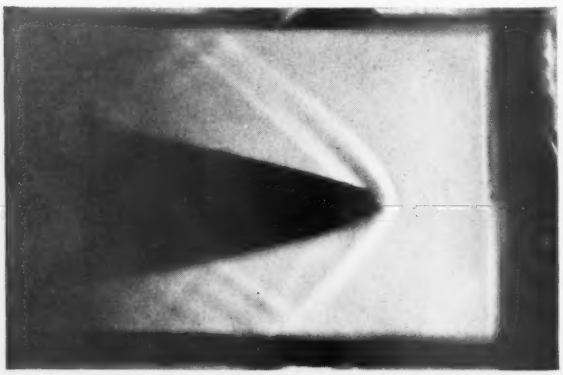


Fig. 2. Schlieren photograph of a model in the test section.

are plotted to show the conventional relationships between Mach Number and pressure and area ratios, respectively.

Nozzle Block Design

An overall view of the nozzle is shown in Fig. 6. It is composed of three sheets of plexiglas which are bolted together. The middle sheet is the nozzle block and must be cut and shaped to the correct size. Since the critical portion of the nozzle is from the throat area out to the end of the test section, it is necessary to compute accurately these dimensions. This will be done by using the graphs in Figs. 3, 4, and 5, given initially, (1) air-supply output in cfm; (2) ratio of the air-supply pressure to the atmospheric pressure (both in psia); and (3) the thickness of the plexiglas nozzle-block sheet, which is the channel width.

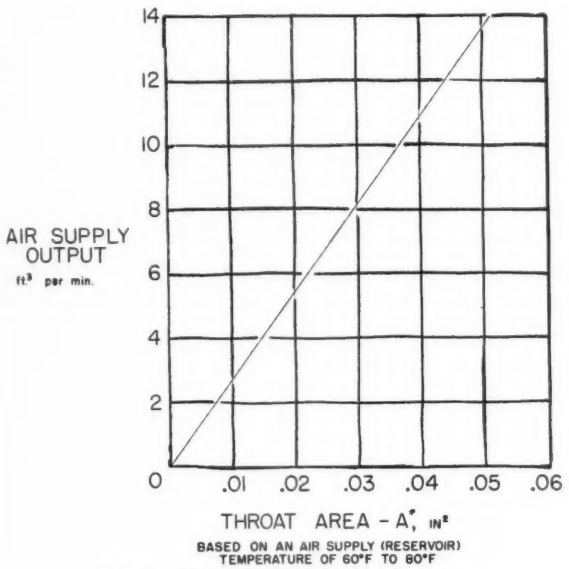


Fig. 3. Air-supply output vs. throat area.

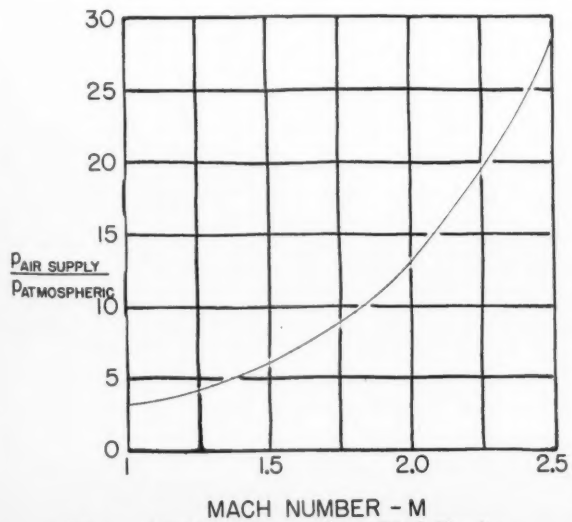


Fig. 4. Absolute pressure ratio vs. Mach Number.

The examples given below and the details of fabrication are for the model shown in the accompanying photographs and drawings. To make these computations:

(a) From Fig. 3 determine the throat area, A^*. *Example:*

$$\text{cfm} = 2.1,\ A^* = 0.0077 \text{ sq.in.}$$

(b) To find the height of the throat, divide A^* by the width of the plexiglas sheet used. *Example:*

$$0.0077/0.12 = 0.0642 \text{ in.}$$

(c) From Fig. 4 determine the test-section Mach Number. *Example:*

$$\frac{p_{\text{air supply (psia)}}}{p_{\text{atmospheric (psia)}}} = \frac{163}{13} = 12.54, \quad M = 1.98$$

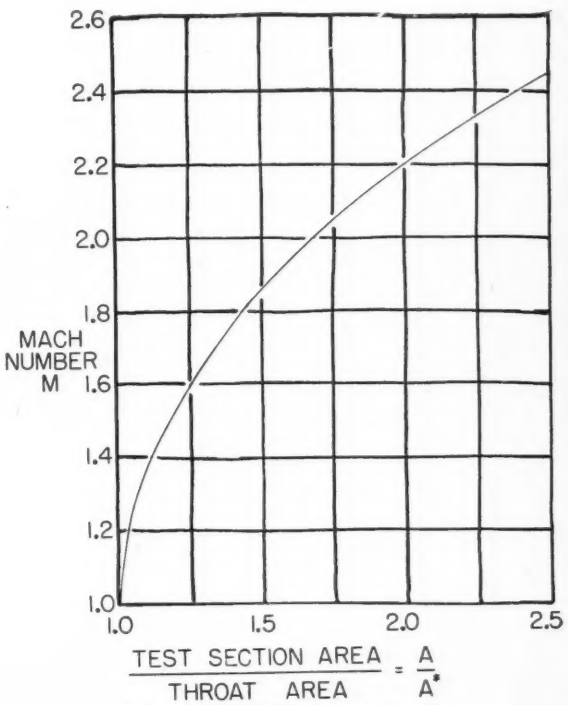


Fig. 5. Mach Number vs. area ratio.

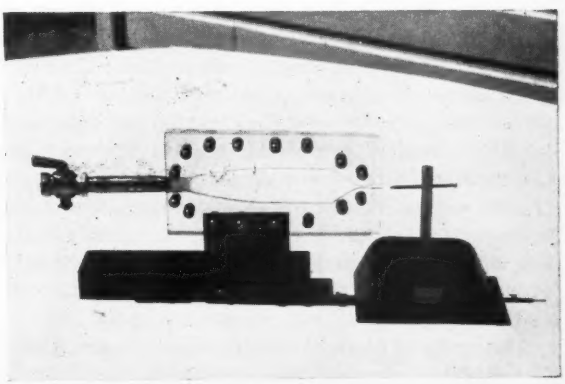


Fig. 6. Plexiglas wind-tunnel nozzle.

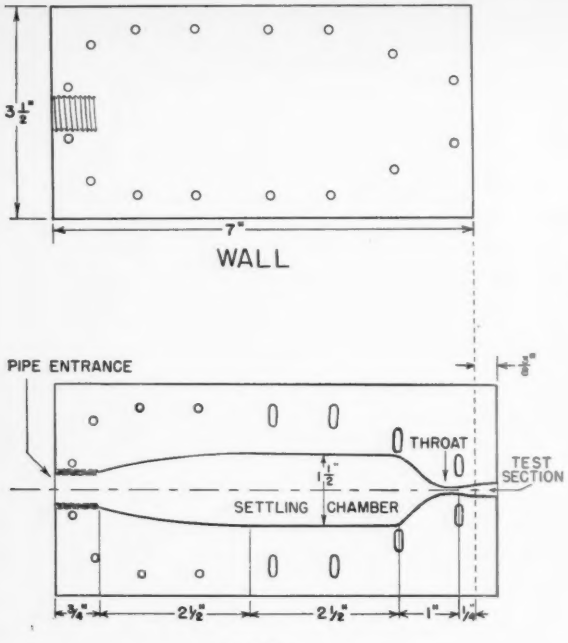


FIG. 7. Wall and nozzle sections.

(d) From Fig. 5 determine the ratio of test-section area to throat area, A/A^*. *Example:*

$$\text{for } M = 1.98,\ A/A^* = 1.65$$

(e) The test-section area then equals the value for A/A^* times A^*. *Example:*

$$1.65 \times 0.0077 = 0.01272 \text{ sq.in.}$$

(f) The test-section height equals the test-section area divided by the plexiglas width. *Example:*

$$0.01272/0.12 = 0.106 \text{ in.}$$

These calculations for the example cited resulted in a throat height of 0.0642 in. and a test-section height of 0.106 in.—miniature dimensions, indeed!

CONSTRUCTION

Now that the throat and test-section dimensions have been determined, the size and shape of the entire nozzle-block section can be scribed on the plexiglas (Fig. 7). These contours can only be "faired" in with a french curve since the dimensions are too small to permit design by the so-called "method of characteristics." The channel from the throat to the end of the test section must follow a smooth contour and be extremely well polished or the air will separate from these boundaries. In case there is an error in the calculation of the throat and test-section areas, the nozzle-block sections have slotted bolt holes to permit an adjustment to be made.

The choice of plexiglas for the nozzle is based on the fact that it can be easily cut, drilled, and tapped, while maintaining good strength characteristics. However, since its optical properties are poor, it is not suitable for the test-section walls. During the development stages of the tunnel, it was noticed that supersonic flow was maintained through the entire test section, even if there were no walls to sustain two-dimensional flow from the beginning of the test section. Consequently, the walls there were eliminated (Fig. 7), which enabled a simplified observation system to be used. As a result, the computed Mach Number holds for the beginning of the test section and seems to diminish slightly farther down.

The nozzle is fixed to a wooden base by a plexiglas brace (Fig. 6). At the intake from the air supply, the three plexiglas sheets are tapped to take a connecting pipe and valve. The final component of the nozzle unit is the model stand, which consists of a heavy metal base and a rod to hold the models. Summarized below are the details and instructions for construction of the complete nozzle unit.

Valve: $^1/_2$ in.; pneumatic or natural gas line type. (Fig. 6).

Entrance pipe: brass; 3 in. in length; $^3/_8$-in. diameter; machine threads to fit valve and tunnel. (Fig. 6.)

Walls: 0.24-in. thick plexiglas. This is the safest minimum thickness for the pressures used. Cut out by saw. Finish with file and emory cloth. Drill and tap with nozzle sections later. (Fig. 7.)

Nozzle block: 0.12-in. thick (or more depending on cfm) plexiglas; outline scribed on and cut out with a saw. Match both halves, and finish with a file and emory cloth. Polish with a fine abrasive such as tooth powder, keeping the contours square with the sides. Match with walls separately, and drill holes with No. 18 drill ($^5/_{32}$ in.). Slot rear holes by drilling, and finish with a jewelers' file (the slots permit the nozzle to be adjusted). Bolt together, and tap $^1/_2$-in. hole for entrance pipe. Smooth out the abrupt edge at the end of the threaded section on the inside of the walls with a hand-tool grinding wheel. (Fig. 7.)

Nozzle stand: wood; 0.24-in. thick plexiglas plate connecting stand to nozzle, fixed or clamped to some overall base for the entire system. Nozzle centerline must be some fixed distance up from base; a 4-in. distance was used for the tunnel shown. (Fig. 6.)

Model stand: heavy metal base; $^3/_8$-in. bolt screwed into base; hole drilled into bolt 4 in. from bottom of base to receive models; right angle hole drilled and tapped with a set screw to secure model. (Fig. 6.)

Models: 3-in. nail point made blunt, wedged or conical in shape; small sphere placed on point; other similar variations. (Fig. 6.)

FLOW OBSERVATION SYSTEMS

In order to see any of the effects of supersonic flow, it is necessary to have an observation system that emphasizes the large changes of the density of air which take place across shock waves. The two systems that will be described are the schlieren and the shadowgraph. A schematic drawing of the schlieren unit is shown in

Fig. 8. Light from an intense source is focused on a slit by a condensing lens system. The light beam is then made parallel by a double convex lens and is passed through the wind-tunnel test section. The beam is focused by a second lens on a screen. Part of this beam is cut at the focal point by a knife edge so that the image of the test section is darkened on the screen. It is this interception of that part of the beam which has been deflected by the density changes of the air in the tunnel which detects the shock-wave picture and corresponding density variations on the screen or on a photographic film. A breakdown of this arrangement is as follows:

Light source: A spotlight reflector bulb with a frosted glass front; a Sylvania R-2 Reflectorflood was used with the tunnel shown; a 100-watt (or larger) projector bulb and condensing system from a small 35-mm. projector; a mercury vapor bulb such as the G-E BH-6; a ribbon filament projection bulb such as the G-E 18A/T10/1P/6V.

Cooling fan: 6 in., fixed base, circulation fan located opposite the side opening of the box.

Condensers: Any set of condensing lenses which focuses the light source on the slit will be sufficient. When using a spotlight reflector bulb, no condensers are necessary.

Slit: In a vertical position; formed by four razor blades to a size $^1/_2$ in. high by $^1/_{16}$ in. wide; the blades are tacked to the inside of the plywood box. Size may be varied with a different light source and lenses.

Box: A plywood box with a hinged ventilating top and door opposite the cooling fan houses the above items. A small hole in front in conjunction with the razor blades forms the slit.

Optical axis: An axis must be maintained for the light source, condensers, slit, lenses, and tunnel test section. This was 4 in. up from the table top for the tunnel system shown.

Lenses: These should be of short focal length for a large image on the screen. Ordinary double convex magnifying glasses 1 in. in diameter and about $1^1/_2$ in. in focal length were used. The first lens focuses the image of the slit back on the slit; the second lens focuses on the screen the image of a model placed in the center of the test section.

Knife edge: A razor blade fixed by a small bolt in a plexiglas stand; the blade hangs vertically. The plexiglas stand can be fused with ether or formaldehyde.

Screen: A sheet of ground glass which may be viewed from the opposite side; a sheet of white paper or cardboard; a camera's ground-glass screen. The lens is removed and film plates or film packs used to take photographs.

Movable units: It is recommended that all of the units outside of the box be put on movable bases so that adjustments can be made easily. A centerline, as well as predetermined positions, should be painted on the base for each of the units.

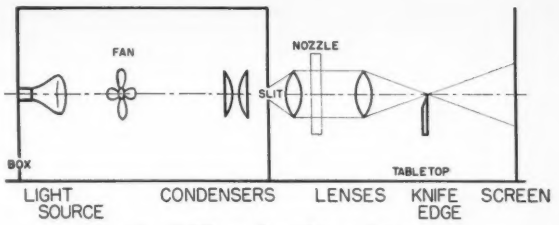


FIG. 8. Schlieren flow observation system.

The shadowgraph system uses a pinhole opening in place of the slit and no lenses or knife edge. A shadow of the shock-wave formation is thrown on the screen or photographic film. A high-voltage spark may be substituted for the light source in the box for either system.

OPERATION

The air supply used in the operation of the tunnel can be a simple tank with a small volume. For instance, a 1.6-cu.ft. tank at 150 psig gave a running time of 50 sec. Larger tanks or comparable air compressors will allow a correspondingly larger size tunnel, which will be easier to construct.

Successful functioning of the tunnel and observation system depends on many varied factors, and often a few adjustments must be made before proper operation is achieved. It is important to check each of the items listed for the whole unit before operating the tunnel. Perhaps the easiest way to be sure that the flow is supersonic is to use a shadowgraph. Any strong light filtering through a pinhole will be sufficient to observe the shock waves on a screen. A readily available light source is a small 35-mm. slide projector with a piece of cardboard over the lens. A pinhole punched in the center of the cardboard completes this simple light system. When shock waves are observed in the flow, check the pressure in the air supply's receiver so that a definite operating range is established. Then the more graphic schlieren system may be set up and adjusted for a clear picture of supersonic flow.

To ready the tunnel for operation:

(1) Tighten all air-hose connections. Check the throat and test-section heights. See that the small bolts on the tunnel are tight. Clamp the tunnel stand to the table top with a large "C" clamp.

(2) Close the entrance-pipe valve and build the pressure up to the operating range. Open the valve and check for large leaks around the air connections, entrance pipe, and tunnel walls. When using a compressor, keep it running to maintain the pressure at a high level.

(3) Place the test section along the optical axis of the observation system, and move the model up into the test section so it is centered in it.

(4) Darken the room; focus the light source on the slit if using condensing lenses.

(5) Focus the image of the slit back on the slit with the first lens.

(6) Focus the image of the model or center of the test section on the screen with the second lens.

(7) Adjust the razor-blade edge so that it cuts the focal point of the beam from the second lens. This is done by moving the blade in the beam until the image of the slit is focused on it or by watching the screen until a uniform darkening occurs. Move the stand so the edge of the blade just cuts the beam and the screen is partially darkened. This critical adjustment will intensify or lessen the shock-wave image.

(8) Place the screen about 12 in. from the razor blade for an initial test until a more satisfactory position can be found.

(9) Check the entire optical axis to see that it is properly aligned—that is, the centers of all elements are the same height from the base. This is extremely important.

(10) The air in the room should be still.

As the valve is opened, the shock waves will be seen to stand around the model or to form in the test section. As the pressure goes down, the waves will slowly go back up into the test section where a vertical or normal shock wave will remain near the throat until the critical pressure ratio for sonic flow is reached. The normal wave will then disappear, and all supersonic flow will cease until the pressure is increased again.

To take a photograph of the waves, substitute a view camera with the lens removed for the screen. Focus the image on the ground glass as before and insert the film plate or film pack. The exposure depends on the type of film and the intensity of the light. The photograph shown (Fig. 2) was taken with a 100-watt projector bulb and super XX film at an exposure of $^1/_{20}$ sec.

If no shock waves appear on the screen, check the ten items listed previously. Be sure that the nozzle walls are flush with the nozzle-block sections and that there are no excessive air leaks that may reduce the mass flow of air to prohibit supersonic flow conditions. Finally, if the flow still is not supersonic, make the throat smaller than calculated by loosening the bolts and sliding the two nozzle-block halves closer together. This will ensure a proper mass flow-area relationship.

Conclusions

(1) A miniature supersonic wind tunnel can be constructed from plexiglas using dimensions as calculated from the conventional compressible, steady flow equations.

(2) The results obtained in demonstrating supersonic flow phenomena are comparable to a much larger and more elaborate tunnel.

(3) The entire wind-tunnel unit can be easily built from readily available, low-cost items of equipment.

Flexural Fatigue Strength of Anodized 24ST Aluminum-Alloy Sheet

(*Concluded from page 30*)

that of the plain specimens. As is shown, the anodizing and painting procedure not only fails to protect the alloy from the extremely detrimental action of corrosion plus cyclic stress but also definitely decreases its efficiency throughout the range tested. At an applied stress of 30,000 lb. per sq.in., the reduction in efficiency is about 23 per cent; at 25,000, it is about 30 per cent.

Conclusions

(1) The presence of a corrosive atmosphere seriously reduces the fatigue strength of 24ST sheet material. Similar results should be expected for all aluminum alloys.

(2) The process of sulphuric-acid bath anodizing decreases considerably the fatigue properties of 24ST aluminum-alloy sheet. Similar results can be expected for other alloys. The very nature of anodizing indicates that its use in regions subject to fatigue is bad design procedure.

(3) While the anodizing and painting of aluminum alloys result in improved resistance to corrosion, this process should by no means be used in areas subject to fatigue or corrosion-fatigue. The corrosion-fatigue resisting properties of 24ST aluminum alloy are decreased by anodizing and painting.

(4) Since the life of specimens tested under corrosion-fatigue conditions may well be a function of the rate of flexure, as well as of the value of the fluctuating stress, direct application to design problems of the numerical data presented is limited.

References

[1] *Instructions for Installation, Operation, and Maintenance of Flexure Fatigue Testing Machine, Model SF-2*, Manual, Sonntag Scientific Co., Greenwich, Conn., July, 1948.

[2] Brick, R. M., and Phillips, A., *Fatigue and Damping Studies of Aircraft Sheet Materials, Duraluminum Alloy 24ST, Alclad 24ST and Several 18:8 Steels*, American Society for Metals. Transactions 29, pp. 435–436, 1941.

[3] McAdams, D. J., Jr., *Corrosion Fatigue of Metals*, American Society for Testing Materials, Proceedings, Vol. 2, 1926.

I.A.S. Preprints

Preprints of Annual Summer Meeting Papers Currently Available

		Member Price	Nonmember Price
388	The Effect of Propeller Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency—R. C. Treseder, M. Brooks, and J. R. Kessler.	$0.35	$0.75
387	Analysis of Redundant Structures by the Method of Elastic Poles—A. F. Ensrud.	0.35	0.75
386	The Shock Ignition Engine—Frank F. Rand, Jr.	0.35	0.75
385	Effect of Creep on Column Deflections—T. P. Higgins, Jr.	0.50	0.85
384	Wing-Body Interference Effects on the Tail Contribution to the Damping-in-Roll of Supersonic Missiles—Harold F. Steinmetz.	0.35	0.75
383	Slender-Body Theory: Review and Extensions—Mac C. Adams and W. R. Sears.	0.65	1.00
382	The Airplane Growth Factor and How to Control It—I. H. Driggs.	0.35	0.75
381	Cockpit Design and Safety—William I. Stieglitz.	$0.50	$0.85
380	New Components for Air-Frame Construction—Report of Progress—John F. Faulkner and John H. Alden.	0.50	0.85
379	Fundamental Aspects of an Hydraulic-Type-Powered Flight Control System—Harold M. DeGroff, Ray C. Binder, John G. Truxal, and J. Robert Burnett.	0.65	1.00
378	Liquid-Coupled Regenerators for Turboprops—A. L. London and W. M. Kays.	0.50	0.85
377	Structural Analysis of Swept, Low Aspect Ratio, Multispar Aircraft Wings—Hans Schuerch.	0.50	0.85
376	Statistical Aspects of Dynamic Loads—Y. C. Fung.	0.65	1.00
375	Theoretical Determination of the Minimum Drag of Airfoils at Supersonic Speeds—Robert T. Jones.	0.50	0.85

Other Preprints of Papers Currently Available

369	Criteria for the Design, Assessment, and Control of Icing Protection Systems—D. Fraser, K. G. Pettit, and E. H. Bowler.	$0.35	$0.75
365	The Effect of Nonuniform Surface Temperature on the Transient Aerodynamic Heating of Thin-Skinned Bodies—A. E. Bryson and R. H. Edwards.	0.35	0.75
364	The Air-Line Pilots Look at Safety—W. W. Moss.	0.50	0.85
363	Flutter Analysis of Complex Airplanes by Experimental Methods—E. Berkeley Kinnaman.	0.50	0.85
362	Performance Data and Operating Experience of a Pressure-Jet Helicopter—Igor B. Bensen.	0.50	0.85
361	Storm and Clear Air Turbulence—An Analysis of the Problem and a Search for Solution—A. F. Merewether and F. C. White.	0.35	0.75
360	Radomes and Aircraft Design—Ernest W. Schlieben.	0.65	1.00
359	Simplified Laminar Boundary-Layer Calculations for Bodies of Revolution and for Yawed Wings—N. Rott and L. F. Crabtree.	0.65	1.00
358	Design Limitations on Aircraft Antenna Systems—J. V. N. Granger.	0.35	0.75
357	On Weak Interaction of Strong Shock and Mach Waves Generated Downstream of the Shock—Boa-Teh Chu.	0.65	1.00
356	Correlation of Some Longitudinal Dynamic Stability Characteristics of a Bell Helicopter from Theory and Flight Tests—Edward Seckel.	$0.35	$0.75
354	An Analysis of the Effect of a Power Boost System on Wing-Torsion Control Surface Flutter—Robert H. Barnes.	0.35	0.75
353	Creep Buckling of Columns—Charles Libove.	0.50	0.85
352	Cross-Country Soaring Criteria Based on Thermal Strength—B. H. Carmichael.	0.35	0.75
351	Visualization of Flow Fields by Use of a Tuft Grid Technique—John D. Bird.	0.35	0.75
350	The Effects on Dynamic Lateral Stability and Controllability of Large Artificial Variations in the Rotary Stability Derivatives—R. O. Schade, O. B. Gates Jr., and J. L. Hassell, Jr.	0.50	0.85
349	Diffuser Efficiency of Free-Jet Supersonic Wind Tunnels at Variable Test Chamber Pressure—Rudolf Hermann.	0.50	0.85
348	Boundary-Layer Studies on a Sailplane—August Raspet.	0.50	0.85
347	The Calculations of Spanwise Loadings for Oscillating Airfoils by Lifting-Line Techniques—M. A. Dengler and Martin Goland.	0.50	0.85
346	Reduction of Gun-Gas Explosion Hazard in Combat Aircraft—J. J. Horan, J. R. Onderdonk, and E. Witkin.	0.50	0.85

Preprints should be ordered by number from:

Preprint Department, Institute of the Aeronautical Sciences

2 East 64th Street, New York 21, N.Y.

Services of the Libraries of the Institute of the Aeronautical Sciences

The services of the Libraries are available to all members of the Institute, to Corporate Members, to advertisers in the AERONAUTICAL ENGINEERING REVIEW and AERONAUTICAL ENGINEERING CATALOG, and, under usual library limitations, to the public. Four specialized services are available.

The Paul Kollsman Lending Library

This lending library service makes available, *without charge*, the latest and more important aeronautical books.

Members may request the loan of any aeronautical or technical book they wish to borrow. Through an exchange agreement with the Engineering Societies Library, any book on general engineering may be borrowed from its great collection of over 160,000 volumes.

A photostating service is available at usual library rates.

Applications for membership in the library and further information will be sent on request.

The W. A. M. Burden Reference Library

This reference library contains over 12,000 aeronautical books, magazines, pamphlets, and reports gathered from world-wide sources and is one of the most complete aeronautical libraries in the world. Material from this library is not available for loan but may be used for reference purposes.

The Pacific Aeronautical Library

7660 Beverly Boulevard

Los Angeles 36, California

Established in cooperation with the aircraft companies the library serves. The leading aircraft companies in or near Los Angeles participate in its support and operation.

This service library for aeronautical research is available to the public for reading privileges. Source material includes aerodynamic and structural research reports, as well as books on drafting, production methods, history, and allied sciences. It furnishes books, periodicals, and pamphlet material to the participating aircraft companies to supplement their engineering libraries.

Technical Information Service

This service has experienced personnel under the supervision of trained aeronautical engineers to compile any information desired. The services range from listing specialized reference books to the preparation of exhaustive bibliographies, digesting of reports, and general surveys of any aeronautical subject. Some of the available services are:

Bibliographies on any aeronautical subject.
Reports on any aeronautical subject.
Digests of aeronautical books, papers, periodicals, and references.
Translations.
Engineering investigations of special aeronautical subjects.
Biographies of individuals engaged in aeronautics.
Photostats of any aeronautical or general engineering material.
Microfilms made on special order.
Photographs made from the Institute's photographic collection.
Drawings and tracings made.

In addition to the services mentioned, any commission that comes within the scope of the Service will be accepted. Special arrangements may be made for work requiring several weeks or months.

Translators are available for accurate transcriptions of all foreign language data. Translations are carefully edited by trained engineers.

Reproductions of any material in the collections of the Institute may be ordered at standard photostat rates.

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.

2 EAST 64th STREET, NEW YORK 21, N.Y.

CORPORATE MEMBERS

OF THE

INSTITUTE OF THE AERONAUTICAL SCIENCES

ACADEMY OF AERONAUTICS, INC.
ADAMS RITE MANUFACTURING COMPANY
AEROJET DIVISION, THE GENERAL TIRE & RUBBER COMPANY
AEROLAB DEVELOPMENT COMPANY
AERONCA MANUFACTURING CORPORATION
AEROPRODUCTS - ALLISON DIVISION, GENERAL MOTORS CORPORATION
AEROQUIP CORPORATION
AGAWAM AIRCRAFT PRODUCTS, INC.
AIRBORNE ACCESSORIES CORPORATION
AIRBORNE INSTRUMENTS LABORATORY, INC.
AIRCRAFT RADIO CORPORATION
AIRESEARCH MANUFACTURING COMPANY, DIVISION OF THE GARRETT CORPORATION
ALLIS-CHALMERS MANUFACTURING COMPANY
ALUMINUM COMPANY OF AMERICA
AMERICAN AIRLINES, INC.
AMERICAN BOSCH CORPORATION
AMERICAN HELICOPTER COMPANY, INC.
AMERICAN PHENOLIC CORPORATION
AMERICAN STEEL & WIRE COMPANY
ANDERSON, GREENWOOD & COMPANY
ARDE ASSOCIATES
ASSOCIATED AVIATION UNDERWRITERS
ATLAS SUPPLY COMPANY
AVIATION ENGINEERING CORPORATION
BAKER STEEL & TUBE COMPANY
BEECH AIRCRAFT CORPORATION
BELL AIRCRAFT CORPORATION
BENDIX AVIATION CORPORATION
- BENDIX INTERNATIONAL DIVISION
- BENDIX PRODUCTS DIVISION
- BENDIX RADIO DIVISION
- ECLIPSE-PIONEER DIVISION
- FRIEZ INSTRUMENT DIVISION
- SCINTILLA MAGNETO DIVISION

THE BG CORPORATION
BOEING AIRPLANE COMPANY
- SEATTLE DIVISION
- WICHITA DIVISION

BOOZ, ALLEN & HAMILTON
BREEZE CORPORATIONS, INC.
THE BRISTOL AEROPLANE COMPANY OF CANADA LIMITED
BROOKS AND PERKINS, INC.
CAL-AERO TECHNICAL INSTITUTE
CALIFORNIA PANEL & VENEER COMPANY
CANADAIR LIMITED
THE CESSNA AIRCRAFT COMPANY
CHASE AIRCRAFT COMPANY, INC
THE CHASE NATIONAL BANK OF THE CITY OF NEW YORK
THE CLEVELAND PNEUMATIC TOOL COMPANY
CLIFFORD MANUFACTURING COMPANY, DIVISION OF STANDARD-THOMSON CORPORATION
CONSOLIDATED VULTEE AIRCRAFT CORPORATION
- FORT WORTH DIVISION

CONSULTANTS & DESIGNERS, INC.
CONTINENTAL MOTORS CORPORATION
CORNELL AERONAUTICAL LABORATORY, INC.
CORNELL UNIVERSITY
CURTISS-WRIGHT CORPORATION
- PROPELLER DIVISION
- WRIGHT AERONAUTICAL DIVISION

DOAK AIRCRAFT COMPANY, INC.
DOELCAM CORPORATION
DOUGLAS AIRCRAFT COMPANY, INC.
- EL SEGUNDO PLANT
- LONG BEACH PLANT
- SANTA MONICA PLANT
- TULSA DIVISION

THE DOW CHEMICAL COMPANY, MAGNESIUM DIVISION
DZUS FASTENER COMPANY, INC.
EASTERN AIR LINES, INC.
EATON MANUFACTURING COMPANY
EDO CORPORATION
ELASTIC STOP NUT CORPORATION OF AMERICA
ELECTROL INCORPORATED
ESSO STANDARD OIL COMPANY
ETHYL CORPORATION
FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
- FAIRCHILD AERIAL SURVEYS, INC.

FAIRCHILD ENGINE AND AIRPLANE CORPORATION
- AL-FIN DIVISION
- FAIRCHILD AIRCRAFT DIVISION
- FAIRCHILD ENGINE DIVISION
- FAIRCHILD GUIDED MISSILES DIVISION
- STRATOS DIVISION

FIRESTONE TIRE & RUBBER COMPANY OF CALIFORNIA
FLETCHER AVIATION CORPORATION
FLIGHT REFUELING, INC.
- FLIGHT REFUELLING (CANADA) LTD.

FLIGHT SAFETY FOUNDATION, INC.
GENERAL ELECTRIC COMPANY
- AIRCRAFT GAS TURBINE DEPARTMENT
- AVIATION DEPARTMENT

GLOBE CORPORATION, AIRCRAFT DIVISION
THE B. F. GOODRICH COMPANY
THE GOODYEAR TIRE & RUBBER COMPANY
GRUMMAN AIRCRAFT ENGINEERING CORPORATION
W. & L. E. GURLEY
HARVEY MACHINE COMPANY, INC.
INDUSTRIAL SOUND CONTROL
INSURANCE COMPANY OF NORTH AMERICA COMPANIES
THE INTERNATIONAL NICKEL COMPANY, INC.
INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION
IRVING AIR CHUTE COMPANY, INC.
JACK & HEINTZ, INC.
JOHNS-MANVILLE SALES CORPORATION
CORYDON M. JOHNSON COMPANY, INC.
EARLE M. JORGENSEN COMPANY
THE M. W. KELLOGG COMPANY
WALTER KIDDE & COMPANY, INC.
KOLLSMAN INSTRUMENT CORPORATION
LAVELLE AIRCRAFT CORPORATION
LEAR INCORPORATED
THE LIQUIDOMETER CORPORATION
LOCKHEED AIRCRAFT CORPORATION
- GEORGIA DIVISION
- LOCKHEED AIRCRAFT SERVICE, INC. (SUBSIDIARY)

LOEWY CONSTRUCTION COMPANY, INC.
LONGINES-WITTNAUER WATCH COMPANY, INC.
MARMAN PRODUCTS COMPANY, INC.
MARQUARDT AIRCRAFT COMPANY
THE GLENN L. MARTIN COMPANY

McDONNELL AIRCRAFT CORPORATION
MELETRON CORPORATION
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
- AERO DIVISION

NATIONAL CREDIT OFFICE, INC.
NORTH AMERICAN AVIATION, INC.
NORTHROP AIRCRAFT, INC.
PAN AMERICAN WORLD AIRWAYS, INC.
THE PARKER APPLIANCE COMPANY
PESCO PRODUCTS DIVISION, BORG-WARNER CORPORATION
PHILLIPS PETROLEUM COMPANY
PIASECKI HELICOPTER CORPORATION
THE PURE OIL COMPANY
RADIOPLANE COMPANY
REPUBLIC AVIATION CORPORATION
E. V. ROBERTS AND ASSOCIATES
A. V. ROE CANADA LIMITED
JOHN A. ROEBLING'S SONS COMPANY
ROHR AIRCRAFT CORPORATION
SCHRILLO AERO TOOL ENGINEERING COMPANY
SEABOARD & WESTERN AIRLINES, INC.
SERVOMECHANISMS, INC.
SHELL OIL COMPANY
SIMMONDS AEROCESSORIES, INC.
SOCONY-VACUUM OIL COMPANY, INC.
SOLAR AIRCRAFT COMPANY
SPERRY GYROSCOPE COMPANY DIVISION OF THE SPERRY CORPORATION
STANDARD OIL COMPANY OF CALIFORNIA
STANDARD OIL COMPANY (INDIANA)
THE STEEL PRODUCTS ENGINEERING COMPANY
STURGESS, INC.
SUMMERS GYROSCOPE COMPANY
TELECOMPUTING CORPORATION
THE H. I. THOMPSON COMPANY
THOMPSON PRODUCTS, INC.
TINNERMAN PRODUCTS, INC.
TOOLKO ENGINEERING COMPANY
TRANS WORLD AIRLINES, INC.
TURBO PRODUCTS, INC.
UNION CARBIDE AND CARBON CORPORATION
- BAKELITE COMPANY
- ELECTRO METALLURGICAL COMPANY
- HAYNES STELLITE COMPANY
- LINDE AIR PRODUCTS COMPANY
- NATIONAL CARBON COMPANY

UNITED AIR LINES, INC.
UNITED AIRCRAFT CORPORATION
- CHANCE VOUGHT AIRCRAFT DIVISION
- HAMILTON STANDARD DIVISION
- PRATT & WHITNEY AIRCRAFT DIVISION
- SIKORSKY AIRCRAFT DIVISION
- UNITED AIRCRAFT EXPORT CORPORATION
- UNITED AIRCRAFT SERVICE CORPORATION

UNITED STATES AVIATION UNDERWRITERS, INC.
VARD INC.
VICKERS, INC.
WESTERN GEAR WORKS
WESTINGHOUSE ELECTRIC CORPORATION
- AVIATION GAS TURBINE DIVISION
- INDUSTRIAL ELECTRONICS DIVISION
- SMALL MOTORS DIVISION

WESTON ELECTRICAL INSTRUMENT CORPORATION
WYMAN-GORDON COMPANY
YOUNG RADIATOR COMPANY

American Helicopter Society News

The 1953 Forum of the American Helicopter Society will be held in Washington, and Charles W. Lefever, of Prewitt Aircraft Co., Mid-Eastern Regional Vice-President, will serve as chairman. This announcement was made at a meeting of the Executive Board in New York on September 23. The Forum will be the ninth in A.H.S. history.

An invitation, extended by the Cleveland Air Foundation, to hold the meeting in Cleveland was declined. President Thomas R. Pierpoint and the Forum Chairman will select the date for the Washington Session.

The Board instructed Lefever to give top priority to plans for a helicopter show in connection with the Forum and suggested preference for an A.H.S.-Military exhibition independent of the annual Armed Forces Day celebration.

An offer from *Aero Digest* magazine to put up a $100 annual cash prize for the winner of The Dr. Alexander Klemin Award was refused by the Board, which felt that the honor should not be tied to another gift and that acceptance of the offer would set a precedent.

Because the magazine is eager to honor its former staff writer on helicopters, the Board suggested that *Aero Digest* offer the prize to the author of the best paper written by a student. It was pointed out that Dr. Klemin was a teacher and inspiration to many students. The Board also suggested that members of A.H.S. serve as judges in the student contest.

In other actions, the Board ordered the president to appoint a committee to revise the Constitution and By-Laws, asked the Executive Secretary to draft a report on possible realignment of A.H.S. regions, and voted to set up a half-yearly rate of $3.00 as dues for members joining after September.

Harry M. Lounsbury, the new Executive Secretary, was given a formal outline of his duties. These will include a revision of the file system, preparation of an A.H.S. history, distribution of papers, enrollment of new members, and cooperation with the Publicity Chairman in preparation of material for release.

Joseph Maitan, I.A.S. Controller, gave a report on A.H.S. finances, showing a balance of $776.10 in the treasury. The society now has 560 members, but, Maitan said, "40 of them are in arrears on dues."

Reports from A.H.S. Regional Vice-Presidents indicate all society members will have a busy winter.

According to Miller Wachs, three meetings have been scheduled for the New England Section, one in Windsor Locks, one in Danbury, and one in Bridgeport.

The Mid-Eastern Region met in Philadelphia on October 16, but its report was too late for this issue of the REVIEW. The speaker was Col. William G. Bunker, Chief of the Transportation Department of the Army. In November, a joint meeting will be held with local I.A.S. members. Charles W. Lefever is regional Vice-President.

John Beadling, Vice-President for the Southwest, reports that seven meetings have been planned, in addition to a tour of the Bell Aircraft plant to be held in cooperation with the Texas Section of I.A.S. Beadling says his region now has 97 active members who are preparing to elect a secretary and treasurer to help him carry out his executive duties.

Ray Young, Vice-President for the Southeast, has been in Korea. In his absence, Les Schneiter announced plans for an October meeting in Washington on the subject of commercial use of helicopters.

CLAUDE O. WITZE
Publicity Chairman, A.H.S.

The Council of the American Helicopter Society has changed its name. Hereafter, it will be known officially as the Executive Board of A.H.S.

Action followed a suggestion from the Aircraft Industries Association, which found some confusion in existence. The helicopter manufacturers are organized as the Helicopter Council of A.I.A.

The new name will be incorporated in a revised A.H.S. Constitution now in preparation.

Contributors to American Helicopter Society News are urged to keep in mind that it takes about 6 weeks for copy to get in print. This page needs material on the activity of regional groups and individual members, but it must be in the hands of the publicity chairman not later than the 5th of the month to appear in the issue of the second month following. Address contributions to Claude O. Witze, Piasecki Helicopter Corporation, Morton, Pa.

News of I.A.S. Members

(*Continued from page 19*)

Special Assistant to the Under Secretary of Commerce for Transportation, Washington, D.C.

David Eisenberg (T.M.), Production Test Engineer, Hughes Aircraft Company. Formerly, Engineering Designer "B," Hughes.

Ralph J. Eschborn (M.), Executive Engineering Manager, Jack & Heintz, Inc. Formerly, Staff Engineer, Jack & Heintz.

Joseph V. Foa (A.F.), Department of Aeronautical Engineering, Rensselaer Polytechnic Institute. Formerly, Head of Propulsion Branch, Cornell Aeronautical Laboratory, Inc.

Second Lieutenant Joseph J. Foster, III, U.S.A.F. (T.M.), Engineering Officer, 3531st Maintenance Squadron, Bryan A.F.B., Tex. Formerly, Sergeant, U.S.A.F., Wind-Tunnel Technician, U.S.A.F. Institute of Technology, Wright-Patterson A.F.B., Ohio.

Bernard Goldman (A.M.), Senior Technical Writer, Publications Department, Ford Instrument Company, Division of The Sperry Corporation. Formerly, Supervisor of Technical Publications, Stanley Aviation Corporation.

Kenneth L. Goldman (T.M.), Research Fellow, Polytechnic Institute of Brooklyn. Formerly, Student, Carnegie Institute of Technology.

M. Carl Haddon (M.), Chief Project Engineer, Lockheed Aircraft Corporation. Formerly, Constellations Project Engineer, Lockheed.

Lester B. Hutchinson (A.F.), Chief Engineer, Aeronautical Engineering Group, Overhaul and Repair Department, Naval Air Station, Corpus Christi, Tex. Formerly, Head, Experimental Structures Section, Structures Branch, Bureau of Aeronautics, Department of the Navy, Washington, D.C.

Captain Roy Jackson, U.S.N. (M.), Overhaul and Repair Officer, Naval Air Station, Alameda, Calif. Formerly, Navy Member and Deputy Director, Executive Directorate, Aircraft Production Resources Agency, Wright-Patterson A.F.B., Ohio.

Clarence L. (Kelly) Johnson (F.), Chief Engineer, Lockheed Aircraft Corporation. Formerly, Chief Research Engineer, Lockheed.

William S. Jones (A.M.), Production Specialist, Headquarters, Southern Air Procurement District, Fort Worth, Tex. Formerly, Civilian Maintenance Officer, Headquarters, Air Materiel Command, Wright-Patterson A.F.B., Ohio.

E. Tilson Peabody (M.), Director, General Motors Air Transport Section, General Motors Corporation. Formerly, Manager, General Motors Aircraft Operations, G.M.C.

Alex Petroff (A.F.), Director of Research, Cessna Aircraft Company. Formerly, Aerodynamics Engineer, Hughes Aircraft Company.

Announcing the new bulletin describing the HAGAN

DIFFERENTIAL TRANSMITTER

(TYPE FRB RING BALANCE)

The Hagan Type FRB Differential Transmitter produces pneumatic output signals which are linear with the pressure differential measured.

This transmitter can be used for generating output signal pressure under the wide range of differential and static pressure conditions, for both liquids and gases, common to the process industries, metallurgical furnace and steam plants.

Bulletin 3M-52 tells you about the Hagan Type FRB Differential Transmitter and what it does. It is yours for the asking.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

for your copy, clip the Coupon

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

Please send me a copy of the new bulletin on the Hagan Differential Transmitter.

Name .....
Position .....
Company .....
Street and Number .....
City ..... Zone ..... State .....

AER-12

DEPARTMENT OF SCIENCE AND TECHNOLOGY BUFFALO PUBLIC LIBRARY

NEW APPOINTMENT

Dwain E. Fritz (M.) has been named Director of Engineering and Assistant to the President, both newly created positions at Jack & Heintz, Inc. For the past 3 years, Mr. Fritz has been the company's Chief Engineer. Prior to joining Jack & Heintz in 1948 as Manager of the Special Aviation Projects Section, he was Manager of the Rotating Apparatus Sect., Aviation Engrg. Dept., Westinghouse's Lima, Ohio, plant.

PROMOTED BY STANLEY

Richard H. Frost (A.F.) has been promoted from his former position as Assistant Chief Engineer—Administrative to that of Chief Engineer for Stanley Aviation Corporation. This was effective September 2, 1952. Prior to joining Stanley in July, 1949, as Project Engineer, Mr. Frost had been with Bell Aircraft Corporation as Test Pilot and Project Engineer. He is a graduate of Rensselaer Polytechnic Institute.

DIRECTOR OF DIESEL POWER

Robert A. Wells (M.), Chief Fuels and Lubricants Engineer, Aviation Section, Gulf Oil Corporation, has been elected to the Board of Directors of Diesel Power Inc. Before joining Gulf, Mr. Wells was associated with the Wright Aeronautical Corporation, Wood-Ridge, N.J. He received his Bachelor of Aeronautical Engineering degree from Rensselaer Polytechnic Institute in 1940.

Laurence W. Sheridan (A.F.), Research Engineer, Aeronautical Division, Minneapolis-Honeywell Regulator Company. Formerly, Associate Professor of Mathematics, The College of St. Thomas.

Robert R. Stark (T.M.), Chief Maintenance Engineer, Eastern Air Lines, Inc., Miami International Airport, Fla. Formerly, Assistant to the Vice-President—Engineering, Eastern.

John B. Wassall (M.), Assistant Chief Engineer, Lockheed Aircraft Corporation. Formerly, Chief Project Engineer.

Frederick Weiner (T.M.), Engineering Designer "B," Power Plant Group, North American Aviation, Inc. Formerly, Thermodynamics Engineer, Consolidated Vultee Aircraft Corporation.

David T. Wilson, Jr. (T.M.), Stress Analyst "A," Northrop Aircraft, Inc. Formerly, Loads Engineer, McDonnell Aircraft Corporation.

Corporate Member News

• **Aeroproducts-Allison Division and Allison Division, General Motors Corporation . . .** On September 16, 1952, the Aeroproducts Division, of Dayton, Ohio, was consolidated with the Allison Division, of Indianapolis, in order to "effect a coordination of activities between General Motors aircraft engine and propeller operations." This move permits not only a closer coordination of engineering staffs but also the joint use of complex and costly facilities at both divisions, including a new major test facility constructed by Allison at Indianapolis. The Dayton operations were given the designation of Aeroproducts-Allison Division. All Aeroproduct employees were transferred to the Allison Division in this change.

• **Airborne Accessories Corporation . . .** William Armstead, Jr., has been appointed Sales Representative for the Kansas City, Wichita, and Dallas areas, with permanent headquarters in Kansas City.

• **AiResearch Manufacturing Company, Division of The Garrett Corporation . . .** The recent annual report to the stockholders contains a listing of more than 150 models of aircraft, engines, and missiles now equipped with AiResearch products. These products, the report says, cover the fields of air-turbine refrigeration, heat-transfer equipment, electric actuators, gas turbines, cabin superchargers, pneumatic power units, electronic controls, cabin-pressure controls, and temperature controls.

• **Allis-Chalmers Manufacturing Company . . .** J. D. Greensward was named Vice-President, Director of Manufacturing, General Machinery Division, of the company.

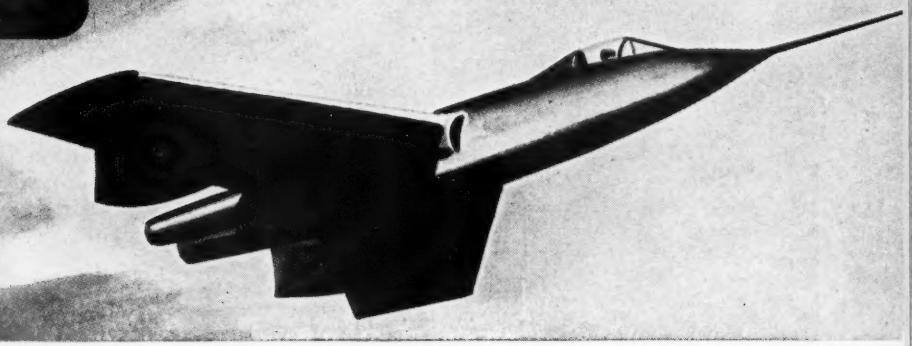
• **Aluminum Company of America . . .** Alcoa's new $45,000,000 smelting works, located 13 miles south of Wenatchee, Washington, along the Columbia River, was dedicated on last September 13. Although construction of the Wenatchee Works is not yet completed, the plant produced its first aluminum in late June. It is expected that the plant will be in full operation by early 1953.

• **Bell Aircraft Corporation . . .** On last September 17, a Bell 47D-1 helicopter was flown nonstop over the great circle route from Bell's Helicopter Division at Fort Worth, Tex., to Bell's Buffalo plant, a distance of 1,234 miles. The elapsed time was 12 hours, 57 min., and 30 sec. for an average speed of 95 m.p.h. This flight was made solo by Elton J. Smith, in accordance with National Aeronautic Association requirements for establishing new world's records. The sealed barograph carried on this flight was forwarded to the National Bureau of Standards in Washington, D.C., for calibration. If this particular flight is recognized as a new world's record, it will surpass by 530.4 miles the official world's long distance record for helicopters. However, it exceeded by 278 miles the longest unofficial cross-country flight made by a helicopter prior to that date.

• **Bendix Aviation Corporation . . .** George E. Stoll, Vice-President and Director of the corporation, has been named group executive in charge of the following divisions: Eclipse Machine, Zenith Carburetor, Skinner Purifiers, Marshall-Eclipse, Hamilton, and Bendix Guided Missile. Mr. Stoll will continue as General Manager of the Bendix Products Division.

Bendix Products Division

FIRST IN FUEL METERING



Where Today's Ideas Become Tomorrow's Achievements

America's world leadership in aviation is due largely to the industry's ability to convert dreams into realities—to apply creative engineering to the solution of every new problem.

The Bendix Products Division of Bendix Aviation Corporation is proud of the part it has been able to play in meeting this challenge of constant product improvement. And Bendix Products pledges its knowledge and resources to a continuation of this program of progress so essential to world leadership.

If the Bendix Products combination of creative engineering and quality production can assist you in the development of carburetion, fuel metering, struts, brakes or wheels—just let us know. Your inquiry will receive prompt attention.

BENDIX · PRODUCTS DIVISION · SOUTH BEND Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N. Y.

LEADER IN LANDING GEAR

Stromberg* Injection Carburetors
Speed-Density Fuel Metering Unit
Fuel Metering Unit for jet engines
Segmented Rotor Brakes
Pneudraulic* Shock Absorbing Struts
Landing Gear Wheels for all types of airplanes
*REG. U. S. PAT. OFF.

AIRBORNE MOTOR

powers canopy on Banshee

An Airborne E-2500 motor, with radio noise filter, provides electrical operation of the canopy actuator on the McDonnell Banshee.

Airborne offers two sizes of motors for applications requiring 26 volt, intermittent duty operation. Both sizes feature magnetic clutch and brake for quick stopping and positive holding during "power off" periods.

If you have applications requiring motors of this type, write us. We'll be glad to send you complete information on these products.

Normal 26 volt D.C. ratings for 1 minute on, 10 minute off, duty cycle, without filter.

model	dia.	h.p.	r.p.m.	wt.-lb.
E-2500	2.5"	.75	8000	5.4
E-3000	3.25"	1.75	7000	8.25

AIRBORNE
ACCESSORIES CORPORATION
1414 Chestnut Avenue, Hillside 5, N.J.

AMERICAN HELICOPTER'S XH-26

The XH-26 "Jet-Jeep," a single-place helicopter powered by two tip-mounted pulse-jets, was developed by American Helicopter Company, Inc., for the U.S. Army under an U.S.A.F.-administered contract. Described as "the smallest and lightest helicopter ever procured by the Army," the XH-26 has a design empty weight of 300 lbs. and a pay load of 600 lbs. This ship, which stands 6 ft. high and can fly 1.5 hours without refueling, has a top speed of 80 m.p.h. It can be either collapsed and carried in a jeep-trailer or air-dropped in a 5- by 5- by 14-ft. container and reassembled in 20 min. by two men.

• **Boeing Airplane Company . . .** The second Boeing Stratofortress, the XB-52, made its maiden flight on October 2 from Boeing Field, Wash. (The first Stratofortress, the YB-52, made its first flight on last April 15.) The XB-52, while the second Stratofortress actually to fly, was the first one to be rolled from the Boeing plant to Boeing Field for ground and taxi tests. This operation, which was done secretly with the bomber covered by tarpaulin and darkness, was accomplished on November 29, 1951. The YB-52 was rolled from the factory on March 15, 1952, and flown 1 month later. Both ships are powered by eight Pratt & Whitney J-57 turbojet engines, which are slung in double pods under the sweptback wings. The Boeing plant at Seattle is tooling up for the production of the B-52. . . . The first of a new type of Superfortress, the TB-50H, was delivered last September to the U.S.A.F. for use by the Air Training Command.

• **Cessna Aircraft Company . . .** R. G. Largent, who was serving as Chief Accountant and Assistant Secretary of the company, has been elected Secretary of Cessna and was appointed Controller in charge of accounting and cost-estimating activities in the Financial Division.

• **Douglas Aircraft Company, Inc. . . .** With the completion of engineering for the DC-7 early last October, the tooling and fabrication departments began to prepare for production. The DC-7, the first of which is scheduled for delivery in 1953, will cruise at 360 m.p.h. and will have a top speed of more than 400 m.p.h. There are two versions of the DC-7, one with a maximum take-off gross weight of 116,800 lbs. and the other with a maximum take-off gross weight of 122,200 lbs. The lighter one carries 4,512 gals. of fuel, while the heavier one carries 5,512 gals. and has an absolute range in excess of 4,800 miles. Both versions will be powered by Wright R-3350 compound engines. The main landing gear of the DC-7 transport can be used as an effective speed brake, inasmuch as the gear has been designed to be lowered at air speeds up to 410 m.p.h. at 20,000 ft. The DC-7 has a wing span of 117 ft., 6 in.; an overall length of 108 ft., 11 in.; and an overall height of 28 ft., 7 in. . . . The jet-powered X-3 research plane, designed for speeds of more than 2,000 m.p.h., arrived at Edwards A.F.B., Calif., last September to be prepared for its initial flight scheduled to take place sometime this fall. The X-3 program is a joint project of the U.S.A.F., Navy, and N.A.C.A.

• **Fairchild Engine and Airplane Corporation, Fairchild Guided Missiles Division . . .** Radar simulators are being produced for the Navy's Special Devices Center under a contract with the Office of Naval Research. These radar simulators will be used in conjunction with flight simulators to train Navy radar operators for jet-interceptor aircraft in the use of air-borne radar under simulated tactical conditions.

• **Fairchild Engine and Airplane Corporation, Stratos Division . . .** A new air-cycle refrigeration unit was recently developed by Stratos for the North American F-86F Sabre jet. This 17-lb. unit delivers 18.5 lbs. of air per min. to the aircraft's cockpit at a temperature of about 28°F. The equipment consists of two air-to-air heat exchangers and an expansion turbine.

NEW HIGH-ALTITUDE SUIT FOR FLYING PERSONNEL

The recently announced emergency high-altitude pressure suit, the T-1, is a radically new type that enables flight personnel to survive in the near vacuum of the upper atmosphere. The above photograph shows "Tex" Johnston (seated) and Art Curren, test pilots of Boeing Airplane Company's B-52 Stratofortress, as they check their T-1 suits before a flight in the jet bomber. Assisting Mr. Curren is Lt. Col. Guy M. Townsend, B-52 Project Test Pilot of the Air Research and Development Command's Air Force Flight Test Center. Major David Mahoney, one of the Aero Medical Laboratory specialists who developed the suit after 6 years of research and development, watches the proceedings. As evidenced in the above picture, the suit is worn uninflated; however, it incorporates a device that automatically inflates the suit whenever the cabin pressurization is lost. The T-1 combines altitude protection with anti-g suit, crash helmet, oxygen mask, earphones, microphone, goggles and defroster, and oxygen bailout bottle. The suit is being manufactured under U.S.A.F. Contracts by Bendix Aviation Corporation, David Clark Company, and International Latex Corporation.

• **General Electric Company . . .** The Aircraft Gas Turbine Division has announced small air-borne gas turbines for starting jet engines without the aid of ground power units. Two types of starters have been developed to meet the varied engine requirements, one powered by the hot gases resulting from the burning of a solid propellant in a replaceable cartridge and the other powered by the products of the combustion of jet fuel and compressed air. In the first-mentioned type, the energy for the start is provided by the burning of a solid fuel contained in a cartridge in a breech; the charge is ignited electrically. In the second type, the air-fuel combustion system, an air-storage bottle, a combustion chamber, and a fuel storage bottle, together with the necessary ignition and pressure control components, are required. This pneumatic system can be charged on the ground from air bottles or from a compressor and in flight from an engine-driven compressor. . . . A new pneumatic system driven by the air from the jet-engine compressor has been designed by the Accessory Turbine Section for supplying either electric or hydraulic auxiliary power. Each unit contains a turbine, reduction gears, and controls. The range of ratings of these systems is virtually unlimited, and, at the present time, drives for alternators up to 60 kva. are in prototype production. For furnishing electric power, the alternator drive is made of a single-stage variable-area axial-flow turbine with reducing gears. For providing hydraulic power, the hydraulic-pump unit consists of a simple high-speed radial inflow turbine, with throttling control, driving a 3,000 lb. per sq.in. variable-displacement hydraulic pump through double-reduction gearing. It is said that this new type of pneumatic-drive unit can be made available in a variety of configurations for driving any type of rotating accessory.

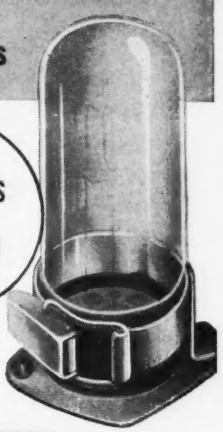
• **The B. F. Goodrich Company . . .** Arthur Kelly, who has been serving as General Manager of Goodrich's Industrial and Aeronautical Products, has been named Vice-President—Manufacturing. Mr. Kelly will assume this new position on January 31, 1953.

• **The Goodyear Tire & Rubber Company and Union Carbide and Carbon Corporation . . .** The Atomic Energy Commission has announced its selection of Goodyear as the operating contractor of the $1,219,000,000 uranium-235 production plant to be constructed between the cities of Portsmouth and Chillicothe in Pike County, Ohio. The entire facility will take 4 years to complete; however, as each individual unit of this gaseous diffusion plant is finished, it will be put into operation by Goodyear. In assuming this operation, Goodyear officials will work

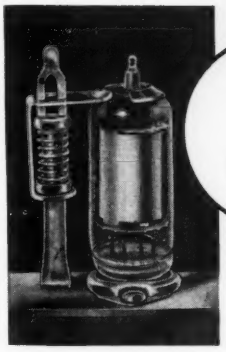
BIRTCHER

TUBE CLAMPS

Hold Tubes in Sockets under all Vibration, Impact and Climatic Conditions



83 VARIATIONS FOR STANDARD TUBES



NEW CLAMP FOR MINIATURE TUBES

You can't shake, pull or rotate a tube out of place when it's secured by a Birtcher Tube Clamp. The tube is there to stay. Made of Stainless Steel, the Birtcher Tube Clamp is impervious to wear and weather.

BIRTCHER TUBE CLAMPS can be used in the most confined spaces of any compact electronic device. Added stray capacity is kept at a minimum. Weight of tube clamp is negligible.

Millions of Birtcher Tube Clamps are in use in all parts of the world. They're recommended for all types of tubes: glass or metal—chassis or sub-chassis mounted.

THERE'S A BIRTCHER TUBE CLAMP FOR EVERY STANDARD AND MINIATURE TUBE!

Write for samples, catalogue and price lists.

THE BIRTCHER CORPORATION
4371 Valley Blvd.
Los Angeles 32, Calif.

smaller than a suitcase

. . . and almost as portable!

AMERICAN ELECTRIC

400 Cycle

MOTOR ALTERNATOR

WEIGHT: Approx 125 lbs.

SIZE: 22" x 12" x 12"

Designed for production and laboratory high frequency power supply requirements. STRONG—SIMPLE—INDESTRUCTIBLE CONSTRUCTION—No delicate moving parts, brushes or springs to wear out or maintain.

Replaces single large, hard-to-get H-F power supply serving multiple purposes . . . *A bank of these compact, flexible units costs far less, provides individual portable power sources for each project, avoids downtime hazards of single unit!*

Meets power supply requirements for AN-E-19 equipment.

OUTPUT: Up to 1000 Watts single phase 115V or up to 1800 Watts three phase 115/200V. Input: 60 cycle AC.

Total harmonic content under 5%; ± 1% voltage regulation.

WRITE FOR DETAILS!

Larger capacities available.

AMERICAN ELECTRIC MOTORS
TRADE MARK

4811 Telegraph Rd.
Los Angeles 22, California

closely with Union Carbide and Carbon Corporation, operating contractors for the gaseous diffusion plants at Oak Ridge, Tenn., and Paducah, Ky. The latter company will also assist in the training of key personnel employed by Goodyear for the new Ohio facility.

• **Hamilton Standard Division of United Aircraft Corporation and Douglas Aircraft Company, Inc.** . . . The Douglas F4D is being equipped with the Hamilton aircycle refrigeration unit to cool the fighter's cockpit and electronics equipment compartment. This refrigeration unit, which weighs 14.7 lbs., is among the lightest of its kind yet developed to deliver 20 lbs. of air per min.

• **Industrial Sound Control, Inc.** . . . A Canadian affiliate, Industrial Sound Control Canada Limited, has been established with offices in Montreal and Toronto, Canada. This new division will handle soundproofing business in the aviation and industrial fields.

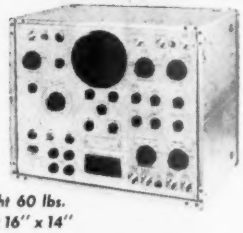
• **Lear, Incorporated** . . . A new heavy-duty radio compass for use in heavy multi-engined aircraft is now in production at the LearCal Division. A completely redesigned version of the Lear ADF-12 Orienter used in private and executive aircraft, this unit, known as the Model ADF-14 Executive, is said to be identical with equipment now being produced for military aircraft. Its frequency coverage is in the following three bands: 195–400 kc.; 475–1,050 kc.; and 1,000–1,750 kc.

• **Linde Air Products Company, Division of Union Carbide and Carbon Corporation** . . . A recently announced water-cooled Heliarc torch for inert gas-shielding arc welding has a rated capacity for continuous duty of 300 amps. Either high-frequency stabilized alternating current or straight polarity direct current can be used. This torch, the HW-10, is designed for welding practically all commercial metals up to a thickness of about 0.125 in.

• **Lockheed Aircraft Corporation** . . . A new medium cargo transport powered by four Allison turboprop engines will be produced at Lockheed's Georgia Division. This ship, designated the C-130, is believed to be the first transport designed from the outset for turboprop power. The Lockheed C-130 incorporates truck-bed level loading, integral loading ramp, a full rear opening for air drops, and a pressurized cabin. Figures on the C-130's design and performance are classified and have not been released. . . . A new multi-purpose foam plastic, styled Lockfoam, has been announced by Lockheed scientists. This plastic, which the company says looks like angel food cake, is a product of 3 years of company research. This material can be poured into the cavities of complex aircraft parts, where it solidifies to act as a structural stiffener. This plastic is said to have many possible uses—e.g., life belts, ear muffs for both cold and noise, packaging insulation, crash helmets, and fireproof doors. Exceptionally tough for its weight, which can be varied from 1.5 to 35 lbs. per cu.ft., Lockfoam is moisture resistant, casts easily to any shape, and adheres itself to enclosing structures.

THE LAB PULSESCOPE®
BY WATERMAN

MODEL S-5-A



Weight 60 lbs.
13" x 16" x 14"

Another Waterman first, a compact, portable wide band pass laboratory oscilloscope with markers that are triggered in synchronism with the incoming signal. Ideal for pulse measurements, such as shape, amplitude, duration and time displacement. S-5-A LAB PULSESCOPE is adaptable to all kinds of electronic work where knowledge of circuit performance is essential. Built in Video delay permits observation of leading edge of triggering pulse. Precision means of amplitude calibration are provided. Sweep can be either repetitive or trigger with 10 to 1 expansion when desired. Internally generated markers, together with Video calibration, provide quantitative data of amplitude, shape, duration and time displacement of pulses. The oscilloscope thus is truly a PULSESCOPE, another Waterman first.

Video amplifier up to 11 mc . . . Video Delay 0.55 μs . . . Pulse rise and fall time better than 0.1 μs . . . Video sensitivity 0.1v p to p/in. . . . Sweep 1.2 μs to 120,000 μs with 10 to 1 sweep expansion . . . Sweep triggered or repetitive . . . Internal markers synchronized with sweep from 0.2 μs to 500 μs . . . Trigger generator with output available externally . . . Built in precision amplitude calibrator . . . Combination case . . . Operates on 50 to 1000 cycles at 115V AC.

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE:

S-4-A SAR	PULSESCOPE
S-10-B GENERAL	POCKETSCOPE
S-11-A INDUSTRIAL	POCKETSCOPE
S-14-A HIGH GAIN	POCKETSCOPE
S-14-B WIDE BAND	POCKETSCOPE
S-15-A TWIN TUBE	POCKETSCOPE

Also RAKSCOPES, RAYONIC
Cathode Ray Tubes
and other equipment

WATERMAN PRODUCTS

• **Marquardt Aircraft Company . . .** The plant and property occupied by Marquardt has been purchased from The General Tire & Rubber Company. The acquisition of this 26-acre parcel of land, which has a 600-ft. front on California's San Fernando Valley Airport, is part of an overall improvement and expansion program.

• **The Glenn L. Martin Company . . .** A high-speed jet-powered seaplane, designated by Martin as Model 275 SeaMaster, is being designed by the company under a Navy contract. It is said that the concept and design of the proposed plane will be radically different from previous designs. Design and performance details, however, were withheld for security reasons.

• **McDonnell Aircraft Corporation . . .** The F-101 Voodoo twin-jet strategic fighter, a modified version of the XF-88 fighter, has been ordered into production by the U.S.A.F. The Voodoo is designed to escort bombers and attack distant targets.

• **Northrop Aircraft, Inc., and Aluminum Company of America . . .** The U.S.A.F.'s Air Materiel Command has been working with Northrop and Alcoa on an experimental project involving a wing section 16 ft. long of exacting tolerances, cast from AZ-92 magnesium alloy.

• **The Parker Appliance Company . . .** A series of newly issued catalog sheets (111A-10-15) on Parker Swing Check Valves made by Parker Aircraft Company is now available by contacting The Parker Appliance Company.

• **Pratt & Whitney Aircraft Division, United Aircraft Corporation . . .** A Pratt & Whitney R-1340-S3H1 reciprocating engine powers the two-place G49-2 trainer, manufactured by Fiat, s.p.a., of Italy, for the NATO countries. The G49-2 trainer has an empty weight of 4,400 lbs. and a gross weight of 5,800 lbs. It has a service ceiling of 25,500 ft. and a top speed at 5,000 ft. of 236 m.p.h.

• **A. V. Roe Canada Limited . . .** The new jet-engine plant at Malton, Ontario, Canada, was dedicated on September 29 by the Rt. Hon. C. D. Howe, Canadian Minister of Defense Production. The Avro Orenda turbojet engine, which was designed, developed, and manufactured in Canada, has been put into mass production in this facility.

• **Simmonds Aerocessories, Inc. . . .** A new 12-page manual for design engineers, covering all phases of the Simmonds precision push-pull control, is offered by the company. Illustrated with numerous photos, drawings, and tables, the booklet covers construction features, types of installations, design details, principal components, and layout planning. . . . A 4-page folder containing design data on a new lightweight amplifier bridge for the Pacitron fuel-gage system has been prepared by the company. The folder includes circuit diagrams, photos, and tables giving installation information.

• **Solar Aircraft Company . . .** A new booklet has been announced which explains "how Solar buttwelding machines can cut costs and improve quality in fabricating smooth cylinders and in joining flat strips and sheets."

McDONNELL
AIRCRAFT
uses
MELETRON
pressure actuated
SWITCHES
on the F2H-3
MELETRON pressure actuated switches provide automatic control of any system by sensing changes in pressure.
MELETRON® CORPORATION
950 NORTH HIGHLAND AVENUE, LOS ANGELES 38, CALIFORNIA
J. M. WALTHEW CO., Boeing Field, Seattle. THOMSON ENGINEERING SERVICE, 708 Hemphill St., Fort Worth and 732 So. Broadway, Wichita. ROUSSEAU CONTROLS Ltd., Montreal Airport, Dorval, Canada. W. M. HICKS, 29-27 Bridge Plaza North, Long Island City, New York.

Designed for dependability

. . . tested (and re-tested) for precision

KOLLSMAN devises, develops and manufactures high-precision **Aircraft Instruments and Controls • Miniature AC Motors for Indicating and Remote Control Applications • Optical Parts and Optical Devices • Radio Communications and Navigation Equipment**

While our manufacturing divisions are engaged largely in defense production, the Kollsman Instrument Corporation welcomes the opportunity to apply its research experience to the solution of problems in instrumentation and control.

KOLLSMAN INSTRUMENTS

KOLLSMAN INSTRUMENT CORPORATION

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

SUBSIDIARY OF Standard COIL PRODUCTS CO INC.

I.A.S. Sections

Chicago Section

Charles L. Bonnette, *Secretary*

On October 1, 1952, the Chicago Section members and their wives were guests of United Air Lines, Inc. Approximately 51 people attended this program. At 6:00 p.m. dinner was served in the cafeteria. The menu equaled that served on United Air Lines' main flight "The Hollywood." At 7:00 p.m. in the auditorium, the Chairman, Dr. Harvard L. Hull, called the meeting to order. He introduced Raymond Mertes, Director of School and College Services, who made the arrangements for this program. Mr. Mertes presented the evening's speaker, Robert E. Johnston, Vice-President—Public Relations, of United Air Lines.

Mr. Johnston presented a most interesting talk entitled "Air Transportation and the Responsibility of the Public Relations Department." He summarized early air-line operations in comparison to those of today and the importance of good public relations in the continuing growth of commercial air travel. His addresss was followed by a motion picture entitled *United 6534*. This film describes a coast-to-coast air-line flight utilizing all of the modern flying aids.

At 8:00 p.m., the group was divided and was conducted upon a tour of United Air Lines' facilities. The tour was informative, especially to the members' wives, and included visits to the Dispatch, Meteorology, Communications, Synthetic, Flight, and Flight Kitchen departments. The tour was further highlighted by an inspection of a Douglas DC-6B air liner.

The tour, ending at 9:00 p.m., concluded the program for the evening.

Cleveland-Akron Section

R. E. Bolz, *Secretary*

The meeting of September 16 in the ballroom of the Hotel Carter, Cleveland, was the first of the year for the Cleveland-Akron Section. The main speaker was C. F. Horne, Administrator, Civil Aeronautics Commission, who was introduced by S. Paul Johnston, I.A.S. Director. Other members at the speakers' table included Claude King, Manager, Cleveland Airport; Arch Colwell, Vice-President, Thompson Products; Dr. E. R. Sharp, Manager, N.A.C.A.'s Lewis Flight Propulsion Laboratory.

Mr. Horne reviewed the report of the Doolittle Committee entitled "The Airport and Its Neighbors," which concerns the public welfare and

The Finest in Testing

3,000,000 LBS.

The largest mechanically driven Universal Testing Machine in the country is now under construction in our shops. This giant 3,000,000 Pound Tension, Compression, Traverse and Fatigue Testing Machine incorporates the last word in Testing Technique. After erection in a large government research laboratory its many new features will greatly assist in reaching new horizons in the research field.

STANDARD UNIVERSAL AND COMPRESSION TESTING MACHINES are available in sizes from 1000 to 1,000,000 pounds, all with precision lapped ram or separate hydraulic weighing capsules. Three lines of machines available—priced to meet your budget.

ACCESSORIES—Stress-Strain Recorder, Extensometers, grips, and all others.

SPECIAL TESTING MACHINES manufactured to meet your specifications in cable testing, torsion and others.

THRUST-LOAD WEIGHING SYSTEMS—Pneumatic, Hydraulic, Electrical.

STRAIN GAGE EQUIPMENT
Our Static Type A Indicators incorporate features new to this field.

SWITCHING & BALANCING UNITS—Static and high speed switching equipment up to 200 gages per second.

STRAIN GAGE BOND CHECKER—checks your strain gage application in 10 seconds.

HUGGENBERGER INSTRUMENTS
We are U. S. A. representatives for Huggenberger equipment.

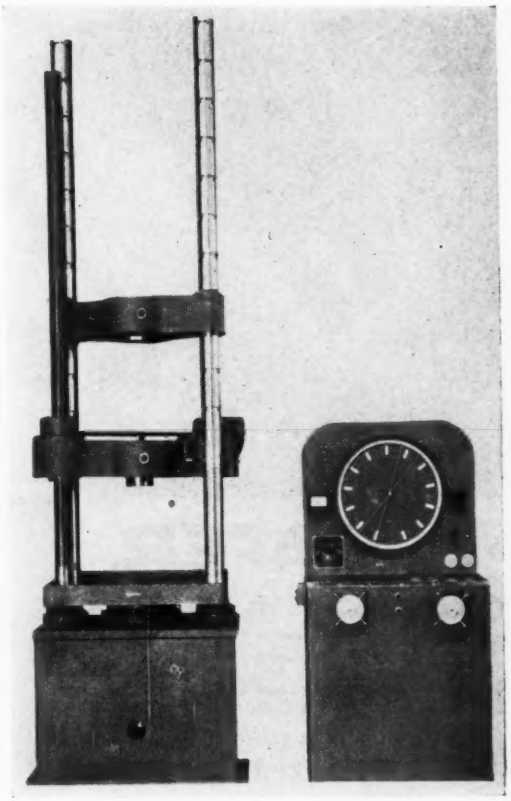
OSCILLOGRAPHS—6 to 60 Channels—Amplifiers 4 to 8 Channels, Bridge Balance Units.

XY RECORDERS—All types—1 to 48 Channels.

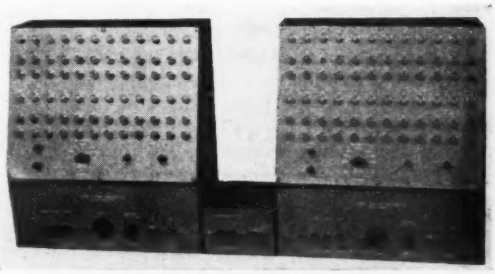
HIGH SPEED CATHODE RAY RECORDERS—paper speeds up to 150″ per second, with 6″ wide paper—up to 8 independent traces.

DEVELOPING & DRYING EQUIPMENT for paper and film, available in combination and automatic units, up to 18″ wide.

PHOTOELASTIC MACHINES—Finest for Laboratory Work.



Standard Testing Machine



High Speed Switching and Balancing Unit

YOUNG TESTING MACHINE COMPANY

Skelton Building, Bryn Mawr, Pa. • **Phone: Bryn Mawr 5-3520**

FOREMOST FOR FLIGHT

SHAFER
CONCAVEX
Aircraft Bearings

Up in the skyways where the real test of bearing performance is made, the superior quality, design and performance of Shafer Aircraft Control Bearings have earned universal preference.

With Shafer dependability you get assurance of maximum bearing life, low cost maintenance, all-round bearing economy . . . and safety. For Shafer Aircraft Bearings are a development of continuous research-engineering that has paced aviation's stiffest bearing specifications throughout the past third century. Write for descriptive literature covering our complete line of both aircraft and industrial bearings.

Features

SHAFER
SELF-ALIGNING
ROLLER BEARINGS
AIRCRAFT • INDUSTRIAL

safety of aviation facilities in larger cities. The reasons behind the preparation of the report, as stated by Mr. Horne, are as follows: (1) the large postwar growth of civil aviation; (2) the larger aircraft in present use and the higher noise level associated with these aircraft; (3) the strained capacity of airports; (4) the growth of cities around airports, causing a high degree of danger during take-off and landing; (5) the fear of the general public, which goes along with the increase in air traffic and noise; and (6) the midwinter air accidents in New Jersey.

The Doolittle Committee, in the preparation of the report during the time between February 20 and May 16, 1952, traveled to many of the larger cities in the country and discussed airport problems with the city and airport officials. They found in these discussions that the local airport is now an extremely vital part of these communities and that the airport facilities in almost all cases were strained. The people living around the airports are complaining more and more about the noise nuisance, as well as the danger. The committee, however, found that the danger due to take-off and landing accidents was extremely small. The committee also found that much of the noise nuisance was a result of poor operation of today's aircraft, and it recommended certain operation methods to minimize the noise nuisance. These included such things as suggested flight patterns and operational recommendations.

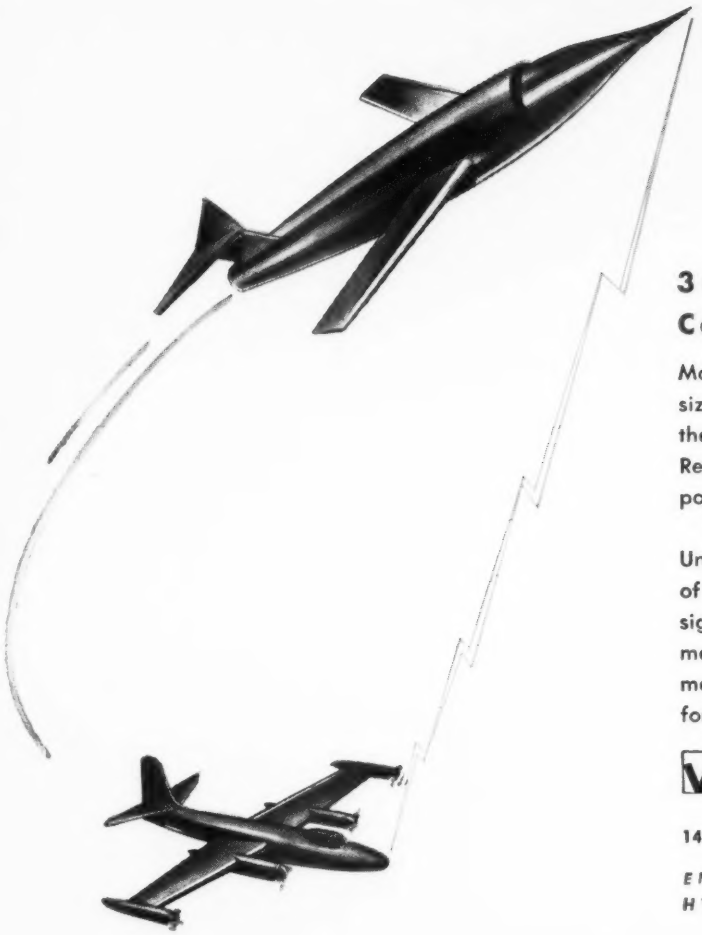
The committee set down a few general principles and ideas for the various cities to apply to their airport problems. Several of these are: (1) Additional development of airports is necessary. (2) The specification of the number of runways needed and the fact that, with modern aircraft, single-direction runways suffice in most of the locations were stated. (3) In future airport installations, an area measuring 0.5 mile in length and 1,000 ft. in width should be used as an overrun space, and no buildings should be erected in this area. (4) The airport should be protected by proper zoning in the areas surrounding the facility. (5) Recommendations for the installation of navigation aids were given. And (6) recommendations on the use of helicopters were also included.

Hampton Roads Section

Albert L. Braslow
Outgoing Recording Secretary

The officers elected for the 1952–1953 year are as follows: Chairman, John A. Harper; Vice-Chairman, William L. Alford; Corresponding Secretary, Julian

LIKE "opening a barn door in a hurricane".....with a FEATHER



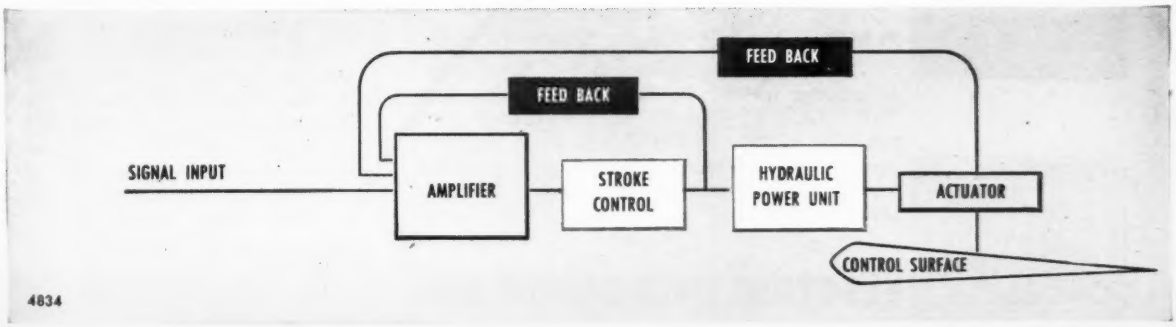
30 Milliamp Signal Controls 50 Horsepower

Modern aircraft control surfaces are not the size of a barn door but the wind across them is several times hurricane velocity. Results are similar . . . it takes plenty of power to control them.

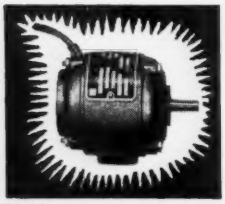
Vickers Electro-Hydraulic Servo Power Units provide rapid and accurate control of up to 50 horsepower with a 30 milliamp signal. This is another Vickers accomplishment in the control of heavy power by means of very minute signal inputs. Write for special bulletin No. SE-18.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1414 OAKMAN BLVD. • DETROIT 32, MICH.

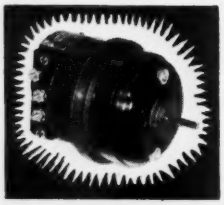
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



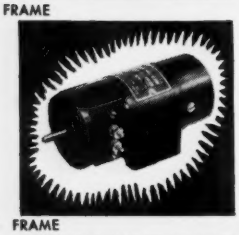
WHEN YOU THINK OF *Instruments* THINK OF **ELINCO**



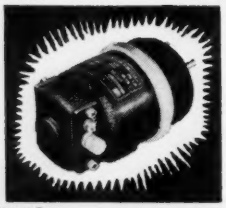
BS FRAME



F FRAME



CB FRAME



FB FRAME

SERVICES

1-, 2-, 3-, & 5-speed Synchronous
AC Dynamically Braked
Adjustable speed Governor-Controlled
Self-Starting
Reversible

SUB-FRACTIONAL MOTORS AND GENERATORS

This time, try Elinco on that "special" problem of instrumentation. With hundreds of variations on over 600 basic models already manufactured, you may find that your special problem has been "pre-engineered" in the design files at Elinco. In tachometers, for instance, Elinco has developed countless high-precision variations of:

AC TACHOMETERS	DC TACHOMETERS
2-4-6-12 Poles	0.9 to 10 Volts at 100 r.p.m.
1-2-3 Phase	Voltage Output Linear
Standard Units	With Speed Within
Sine Wave Units	1% in Either Direction

FEATURES

Instrument-type precision ball bearings.
Every unit balanced dynamically . . . and *individually tested* under *specific load conditions.*
Ultra-precision manufacture of *all* parts.

PLUS

ANY physical or electrical variation to meet your specific requirements.
OVER 600 basic models with hundreds of variations already manufactured.

TYPES

AC • DC • Universal
Servo • Self-synchronous

RATINGS 1/3000 to 1/6 H P

PHASES One-, two-, and three-phase

WINDINGS

Compound • Shunt • Series
Separately Excited • Split Field
Permanent Magnet • Reluctance
Hysteresis • Stabilized Hysteresis
Induction • Drag Cup

PLEASE

. . . outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO

ELECTRIC INDICATOR CO.

CAMP AVENUE • SPRINGDALE • CONN.

D. Maynard; Recording Secretary, H. Herbert Jackson; and Treasurer, Albert L. Braslow.

San Diego Section

H. L. Braasch, *Secretary*

A dinner meeting was held on September 18 in the Marine Room of the Hotel San Diego.

Following the dinner, a short business session was held. Chairman W. C. Heath announced the election of the following officers for the coming year: Chairman, Richard P. White; Vice-Chairman, Herman L. Braasch; Treasurer, James G. Wenzel; Corresponding Secretary, Earl R. Hinz; and Recording Secretary, Harry C. Matteson.

After the business session was concluded, an interesting talk was given by Brig. Gen. Kern D. Metzger, who spoke on the subject "Titanium in Defense." In his present position as Chief of the Industrial Resources Division of the Air Materiel Command, he is playing an important role in the Air Force's titanium development program.

General Metzger described titanium as our newest military ally and referred to it as a "middle-weight champion." Since titanium weighs only 56 per cent as much as steel, General Metzger pointed out that it is our newest ally in the battle to keep down weight of aircraft. It will have its greatest application in an intermediate temperature range—i.e., between temperatures permissible for aluminum and higher ones requiring the use of steel.

General Metzger pointed out that the Navy looks to titanium for the answer to many problems with salt-water and salt-air corrosion for both aircraft and seagoing vessels.

As to supply, he indicated that the world is one vast stock pile of metal. One-sixteenth of the earth's crust is titanium. It is the fourth most available structural metal today. The speaker further pointed out that the Air Force has drafted a program to stimulate production of titanium by private industry and has set aside $5,000,000 to develop the metal.

Following General Metzger's talk, a brief presentation was made by Roy Watkins, Chairman of the Air Force committee coordinating titanium developments. Mr. Watkins displayed many samples of parts that were fabricated from titanium, including bolts, sheet-metal parts, castings, and forgings, as well as a gun made entirely of titanium.

Approximately 125 members and guests attended the meeting. Chair-

PRODUCT AND PROCESS ADVANTAGES

increase demands for Ductile Iron

DUCTILE IRON PROVIDES mechanical properties which approach those of cast steel. In addition, it combines the *machinability and wear-resistance* as well as the *fluidity and castability* of cast iron.

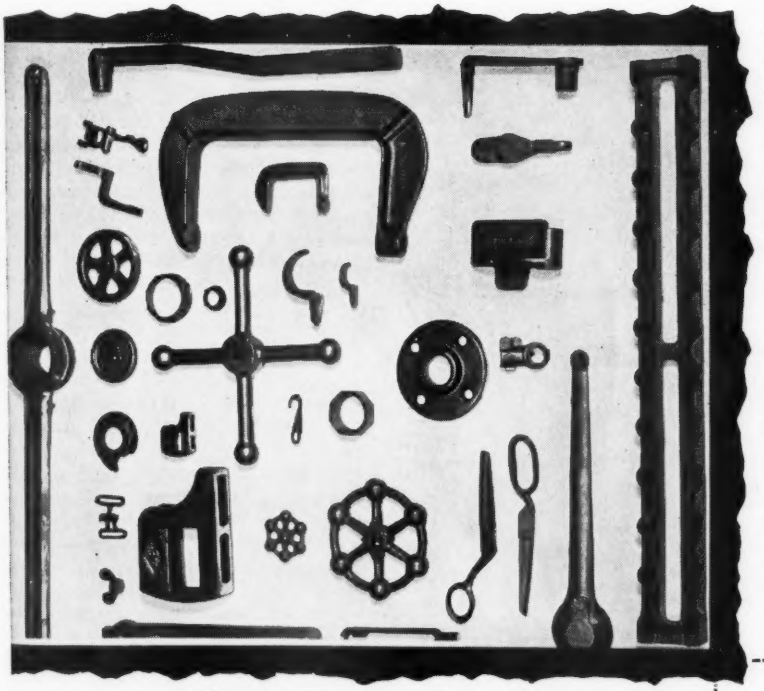
Presence of spheroidal rather than flake graphite not only gives this new material ductility that is unique among cast irons, but contributes much to its other exceptional properties.

REMARKABLE CHARACTERISTICS OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness.

2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core.

3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.



COURTESY OF ACME SHEAR COMPANY, BRIDGEPORT 1, CONN.

4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.

5. It can be satisfactorily welded.

6. It resists oxidation and growth to an extent never before available in gray iron castings.

7. It can be cast in intricate shapes not normally feasible for cast steel.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron... mail the coupon now.

Ductile Iron offers excellent castability, high mechanical properties and good machinability. Castings show superior pressure tightness, good elastic modulus and resistance to shock. They range from those weighing a few ounces . . . with sections as thin as one-tenth of an inch . . . to 50-ton anvil blocks with sections 4' thick.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, NEW YORK

EMBLEM OF INCO SERVICE

The International Nickel Company, Inc.
Dept. 20, 67 Wall Street
New York 5, N. Y.

Please send me a list of publications on:
DUCTILE IRON

Name_____ Title_____

Company_____

Address_____

City_____ State_____

DEPARTMENT OF ECONOMICS BUFFALO PUBLIC LIBRARY

man Heath adjourned the meeting and expressed his thanks to all of the previous officers and Institute members for their fine cooperation with him during the past year.

Wichita Section

Wilfred Pearce
Outgoing Secretary

Sixty-three persons attended the meeting of September 10, which was held at the Crolls English Grill, Wichita, Kan. Chairman Henry F. Waring, Jr., presided.

As a result of an election held at this meeting, the following persons will serve in official capacities during the 1952–1953 year: Chairman, Melvin Snyder; Vice-Chairman, Herbert Dickard; Secretary, Donald Ahrens; and Treasurer, Charles Petrie.

The speaker of the evening was Carl J. Wenzinger, Chief Aerodynamicist and Head of the Aeronautical Department at Sverdrup and Parcel, Inc. Mr. Wenzinger, whose subject was the "New Supersonic Research Center of the U.S.A.F.," discussed the problems encountered in the design of the facilties for the Arnold Engineering Development Center at Tullahoma, Tenn.

Student Branches

Academy of Aeronautics, Inc.

Frederick Berger
Corresponding Secretary

New elections for officers of the academy's I.A.S. Student Branch were held after the graduation of the outgoing officers at the end of July, 1952. These elections took place at two meetings, one held during the second half of July and the other on October 2, 1952.

The following is a list of the present officers whose terms will cover the period from September, 1952, to March, 1953, and who were elected by the majority of the eligible student votes: Chairman, Sherman Martin; Vice-Chairman, Jerome Cohen; Corresponding Secretary, Frederick Berger; Treasurer, Eli Ladizensky; and Recording Secretary, Herbert Schub.

The October 2 meeting was concluded with a travel film, *Wings to Hawaii*, which was enjoyed by all those present.

The Aeronautical University, Inc.

On September 18, an election of officers was held with the following results: Chairman, Lyman Welliver; Vice-Chairman, Ralph Flentge; Secretary, Robert Johnson; and Treasurer, John Martyr. The outgoing Chairman, Raymond Miller, presided. Eleven students were present.

Catholic University of America

William Elsen, *Secretary*

On Wednesday evening, October 1, the Catholic University of America Student Branch of I.A.S. held its first meeting of the academic year. The chairman, Earl Erickson, called the group of 22 members to order and appointed several committees for the year, in order to facilitate the activities of the branch. One of the most important committees, consisting of Daniel Coen, Jr., and Ben MacMullen, was assigned the job of arranging tours to various factories and laboratories in the vicinity.

The speaker for the evening was Dr. Max M. Munk, who gave a brief talk entitled "Reliability Control of Missile Design." Dr. Munk explained that, in the design of guided missiles at the present time, reliability must be a factor that is planned for and not something which is just left to chance. He pointed out that, if one small part of the complex missile were unreliable, the missile itself became just as unreliable. Therefore, he said that it was

N.A.I. Dinner Meeting: *Members and Guests of the Northrop Aeronautical Institute Student Branch are shown as they listen to the address delivered by John K. Northrop, President of Northrop Aircraft, Inc. The occasion was the September 12 dinner meeting given by the N.A.I. branch.*

the attempt of the builder to make every part as perfect as humanly possible. He emphasized the importance of this aspect of missile design in the light of the large cost of every missile which would be wasted if the missile were unreliable and failed to perform its intended function.

Mississippi State College

Thomas C. Pope
Corresponding Secretary

The Mississippi State College Student Branch of the I.A.S. held the first meeting of the fall semester on September 23 for the purpose of general organization. The following officers were elected: Chairman, Al Backstrom; Vice-Chairman, Jimmy Hayden; Secretary and Treasurer, Gilbert Hoffman; and Corresponding Secretary, Cameron Pope.

Plans were started at this meeting for the Southeastern Regional Meeting of the I.A.S. Student Branches to be held on this campus in April of next year.

New York University

John Schmitt, Jr., *Secretary*

The first meeting of the fall term of the New York University Student Branch was held on October 2. Chairman William Zeltner presided over the 30 members present. An organizational meeting was held, during which plans for the coming year's program were discussed. Included in this program are a series of smokers at which industrial representatives will speak. Following this discussion, a C.A.A. film, *Hydraulic Brakes*, was shown.

Northrop Aeronautical Institute

Jason L. Araujo
Corresponding Secretary

The Northrup Aeronautical Institute Branch of the Institute of the Aeronautical Sciences held its second triannual dinner meeting on the night of September 12, 1952. Over 100 members and guests heard John K. Northrop, President of Northrop Aircraft, Inc., deliver an interesting and informative talk on the future of pilotless aircraft and the development of the Northrop flying wing.

Among the guests present were: E. W. Robischon, Manager, I.A.S. Western Region, and Mrs. Robischon; J. L. McKinley, Director of Northrop Aeronautical Institute; H. R. Filson, Director of Engineering at N.A.I.; and G. W. Blaisdell, Faculty Adviser of the Student Branch.

The president officers are: Harold Robins, Chairman; Andrew Jessen, Vice-Chairman; David McClelland, Treasurer; Ellsworth Hardy, Recording Secretary; and Jason Araujo, Corresponding Secretary.

Polytechnic Institute of Brooklyn

George M. Meyers, Vice-Chairman of the Student Branch, spoke at the September 29 meeting on the "Orientation and Listing of New Members." In this talk, Mr. Meyers explained to the new members the purpose and membership conditions for the I.A.S. Sections and Students Branches. For the benefit of the freshman, he described the basic elements of a conventional airplane, including the various control surfaces and their respective functions. Chairman Fritz Blomback presided; 53 students were present.

United States Naval Academy

On September 12, Midshipman C. H. Kruse, Co-Chairman, presided at the meeting attended by 35 students. Midshipman Carl H. Builder presented a talk on "Ram-Jet Flame Stabilization," in which he discussed and described, by means of diagrams, the principles of ram-jet flames and diffusers, as well as ram-jet inefficiency due to diffuser design and difficulty. The speaker proposed a solution to the problems in ram-jet diffusers by sketching his design for an auxiliary ram-jet flame stabilizer with a deflector plane at its afterend for spreading the fuel to the areas of main fuel injection. A question-and-answer period followed. A film, *Military Use of the Helicopter*, concluded the meeting.

▶ At the September 19 meeting, two Bureau of Aeronautic films were shown to the 50 attending students. These were *The Tiny Tim* and *Taxi Accidents*. Midshipman J. A. Muka, Co-Chairman, presided.

West Virginia University

Elections were held at the September 24 meeting at which Acting Chairman Malcolm Ullock presided and eleven students were present. The following persons were voted into office for the fall term: Chairman, David Anderson; Vice-Chairman, James Shrout; Recording Secretary and Treasurer, Malcolm Ullock; and Corresponding Secretary, Charles Bartlett. The Honorary Chairman is Prof. Leon Z. Seltzer, Head of W.V.U.'s Department of Aeronautical Engineering. Professor Seltzer addressed the meeting on "Your Responsibilities in the I.A.S." A film entitled *Fog* was shown.

▶ On October 1, the second meeting of the fall term was opened by Chairman Anderson with six students present. After the business part of the meeting was concluded, Professor Seltzer gave a "Report on the Summer Meeting in Los Angeles."

DIALCO

for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

ACTUAL SIZE
Cat. #613529-211

or

ACTUAL SIZE
Cat. #8-1930-621

THE BIG ONE

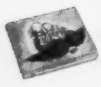
This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

THE LITTLE ONE

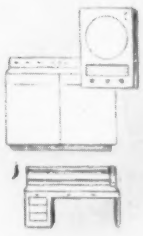
The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

Dialco HAS THE COMPLETE LINE of INDICATOR and PANEL LIGHTS

Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.



Write for the Dialco HANDBOOK of PILOT LIGHTS



Foremost Manufacturer of Pilot Lights

The DIAL LIGHT COMPANY of AMERICA

60 STEWART AVENUE, BROOKLYN 37, N. Y. HYACINTH 7-7600

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Berler, Irving, M.S. in Aeronautics, Sr. Proj. Engr., Sperry Gyroscope Co. Div., The Sperry Corp.

Brilmyer, Harold G., B.A.E., Asst. to the Pres., Huck Manufacturing Co.

Gustafson, Frederic B., M.S. in M.E., Aero. Research Scientist, N.A.C.A., Langley A.F.B.

Elected to MEMBER Grade

Bert, Jack A., B.S., Sr. Research Engr., California Research Corp.

Bosworth, W. L., B.A., Supvr. of Exp. Liaison, Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Haller, Howard E., Member of Tech. Staff, Guided Missiles Div., Hughes Aircraft Co.

Jagiello, Leonard T., Chief Aerodynamicist, Guided Missiles, Naval Ordnance Test Station (China Lake).

Johnson, Theodore K., Jr., B.S.M.E., Proj. Engr., General Electric Co. (Lynn).

Lathrop, Richard C., Ph.D. (E.E.), Capt., U.S.A.F.; Proj. Engr., Flight Control Unit, Wright-Patterson A.F.B.

Murphy, Archie C., A.A., Flight Test Engr., Lockheed Aircraft Corp.

Pederson, Jerard M., B.S. in Met. Engrg., Sect. Engr., Product Planning on New Turbojet Engines, General Electric Co. (Lockland).

Pierson, John D., M.S. (Aero.), Supvr., Hydrodynamics, The Glenn L. Martin Co.

Robbins, Norman B., Aero.E., Proj. Engr., Consolidated Vultee Aircraft Corp. (Ft. Worth).

Schmill, Wesley C., B.S., Tech. Engr., Special Proj. Operations, ANP Proj., General Electric Co.

Schram, John D., Chief, Mech. Actuating Systems Unit, U.S.A.F., Hq., Wright Air Development Center.

Witchell, Arthur S., Jr., B.S., Supvr. of Flight Operations, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Transferred to MEMBER Grade

Beverage, Arthur W., Jr., B.S. in C.E., Asst. Supvr., Spares Sect., Sales Dept., Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Burlage, Henry, Jr., B. of Ae.E., Asst. Prof., Dept. of Mech. Engrg., Case Institute of Technology.

Gilbert, Arthur C., M.Ae.E., Partner, GLW Research.

Gray, Robin B., M.Sc. in Ae.E., Research Assoc. in Aero. Engrg., Princeton Univ.

Hilton, Harry H., Ph.D., Asst. Prof., Dept. of Aero. Engrg., Univ. of Illinois.

Montany, Eugene R., B.Ae.E., Group Leader, Research Dept., United Aircraft Corp.

Webb, Henry G., Jr., M.S. in Ae.E., Aerodynamics Engr.—Analysis, North American Aviation, Inc. (Downey).

Elected to Associate Member Grade

Bucci, August J., Design Change Rep., Lockheed Aircraft Corp. (Marietta).

Heine, C. J., B.S., Asst. Service Mgr., Canadair, Ltd.

Hunt, Charles P., Aircraft Sales Engr., Baker Steel & Tube Co.

Thorson, George O., B.A., V.-P. & Sales Mgr., Meletron Corp.

Vaughan, George L., Supvr., Tech. Data Group, Engrg. Dept., Lockheed Aircraft Corp. (Marietta).

Elected to Technical Member Grade

Badertscher, Robert F., M.S. in Ae.E., Principal Aero. Engr., Battelle Memorial Institute.

Fox, Norman L., B.S., Aerodynamicist "B," Douglas Aircraft Co., Inc. (Santa Monica).

Osborn, James R., B.Sc., Aerodynamicist "B," Aerodynamics Sect., Boeing Airplane Co. (Seattle).

Ott, Owen, B.S., Jr. Engr., Instrument Development Group, Boeing Airplane Co. (Seattle).

Petersen, Peter L., B.S., Pfc. & Test Engr., U.S.A., Transportation Research & Devel. Station (Ft. Eustis).

Toms, Clinton J., Design Draftsman, A. V. Roe Canada, Ltd.

Traynor, John S., M.S., Aerodynamicist, Douglas Aircraft Co., Inc. (Long Beach).

Transferred to Technical Member Grade

Addison, James L., B. of Ae.E., 2nd Lt., U.S.A.F.

Allen, Edward M., B. of Ae.E., Aerodynamics Engr., Propeller Div., Curtiss-Wright Corp.

Annand, Chas. William, Jr., B.S., Engr., Test Sect., Northrop Aircraft, Inc.

Balsells, Joan C., B.S., Aero. Engr.—Trainee, A.D.C., Wright-Patterson A.F.B.

Barton, William R., B.S. in Ae.E., Staff Member, Sandia Corp.

Bergstedt, William C., M.S. in Ae.E., 2nd Lt., U.S.N.; Prod. & Engrg. Officer, BAR Staff, Consolidated Vultee Aircraft Corp. (San Diego).

Bernstein, David, B. of Ae.E., Grad. Student, Georgia Institute of Technology.

Bowers, Allen A., B.S., Aero. Engr., Engineering & Research Corp.

Many products . . . One Standard I.Q.*

*Instrument Quality

There is one characteristic common to all Giannini instruments—they are built to rigid, instrument-quality standards. They are instruments with an earned reputation of offering the utmost in mechanical and electrical fineness—resulting from outstanding craftsmanship and rigorous calibration, testing and inspection procedures. Your job requirements can be met or exceeded by Giannini IQ instruments.

For catalog and engineering data on these and other fine instruments write:

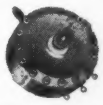
ACCELEROMETERS
Linear Transmitting

ANGULAR TRANSMITTERS
Pitch, Yaw, Pitot Static

GYROS
Free • Rate Vertical • Directional

POTENTIOMETERS
Low Torque • Many types and resistance values

PRESSURE SWITCHES
Absolute • Differential Gage



PRESSURE TRANSMITTERS
Absolute • Differential Gage • (Resistance type)

STEPPING POSITIONERS
Intermittent Rotary Power

TEMPERATURE DEVICES
For high or low temperature

INSTRUMENTS CONTROLS

Giannini

G. M. GIANNINI & CO., INC., PASADENA, CALIFORNIA, EAST ORANGE, NEW JERSEY

Brown, Ellis W., B.S. in Ae.E., Jr. Engr.—Research, Lockheed Aircraft Corp.

Brulle, Robert V., B.S., Capt., U.S.A.F.; Proj. Engr., Fighter Sect., Weapons System, ADC, Wright-Patterson A.F.B.

Burleson, Bordon J., B.S. in Ae.E., Lt. (j.g.), U.S.N.; Ferry Pilot, Naval Air Station (San Diego).

Charest, Armand E., A.E., Mathematician "A"—Stress Analysis, Douglas Aircraft Co., Inc. (Santa Monica).

Coenson, Martin, B.S. in Ae.E., Engrg. Trainee, Republic Aviation Corp.

Coleman, Walter J., B.S., Engrg. Draftsman "A," Douglas Aircraft Co., Inc. (Long Beach).

Crews, Arthur A., B.S.M.E. (Aero.), Guided Missiles Aerodynamicist, Grumman Aircraft Enginering Corp.

Dean, William E., B. of Ae.E., 2nd Lt., Pilot & Aircraft Maintenance Officer, U.S.A.F.

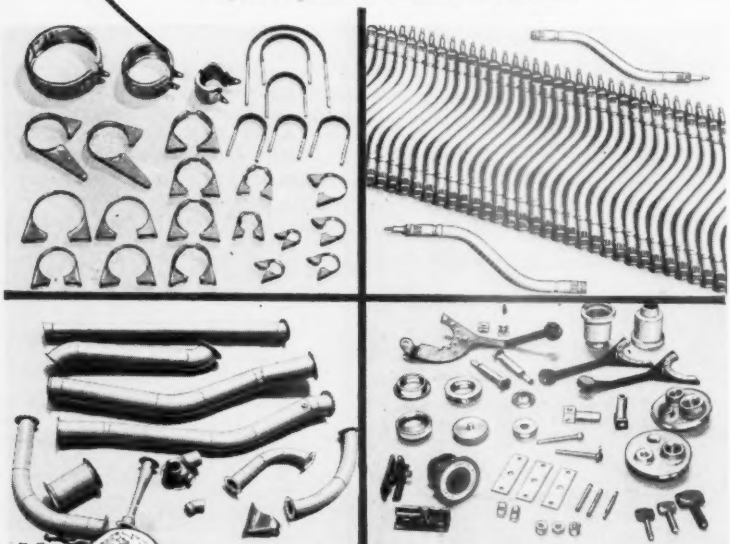
Dearing, Gerald P., B.S., Drafting Engr. "B," Georgia Div., Lockheed Aircraft Corp.

Delforge, George, Jr., B. of Ae.E., Flight Test Analysis Engr., Chance Vought Aircraft Div., United Aircraft Corp.

Dufrane, Kenneth H., B. of Ae.E., Power Plant Engr.—Guided Missiles, Grumman Aircraft Engineering Corp.

Dunstan, John, Engrg. Draftsman "A," North American Aviation, Inc. (Downey).

Unlike the proverbial horseshoe nail that *lost* the battle, today's military aircraft *win* battles because of the quality of their *components.*
Where specifications demand precision machining, quality stamping, dependable certified heliarc or continuous seam welding, or tooling, major aircraft manufacturers invite UNIVERSAL to bid.
A major west coast production facility, UNIVERSAL offers long experience in the priceless "know how" that is so important in turning out quality in volume and guaranteeing "on-schedule" delivery — at competitive prices.
Write for our new facilities brochure . . . let us bid on your requirements. Nationwide service.



UNIVERSAL METAL PRODUCTS, INC.
Tools • Dies • Metal Stampings • Aircraft Parts
Serving America's Aircraft Industry
2311 West Orange Street
Cumberland 3-3115
Alhambra, California

Eisele, Donn F., B.S., 2nd Lt., U.S.A.F.; Student Pilot, Goodfellow A.F.B. (San Angelo).

Ferguson, Wesley I., B.S., Thermodynamicist, Northrop Aircraft, Inc.

Gordon, James A., B. of Ae.E., Jr. Engr., Wind Tunnel Group, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Graves, George F., B.S.M.E. (Aero.), Engrg. Trainee, Boeing Airplane Co. (Seattle).

Haglin, Paul D., B. of Ae.E., Structures Engr., Bell Aircraft Corp. (Buffalo).

Hartz, Billy J., B.S. in C.E. (Struct.), Grad. Student, Univ. of California.

Haskell, F. Richard, Jr. Engr.—Draftsman "A," Landing Gear & Hydraulics Design Sect., Northrop Aircraft, Inc.

Haugan, Gregory T., B.S.M.E. (Aero.), Design Engr., Wing & Tail Group, Helicopter Div., McDonnell Aircraft Corp.

Henry, Charles R., B. of Ae.E., Aerodynamicist, Hamilton Standard Div., United Aircraft Corp.

Hoffmann, William F., B.S., Engr.—Power Plant Research, Boeing Airplane Co. (Seattle).

Hundley, Marvin L., B. of Ae.E., Aerodynamics Engr., Consolidated Vultee Aircraft Corp. (Ft. Worth).

Hurd, William C., Engrg. Draftsman "A," North American Aviation, Inc. (Downey).

Jacobson, Charles A., B.S., Flight Test Engr., McDonnell Aircraft Corp.

Johnson, Helmer L., B.S. in Ae.E., Research Engr., Aerophysics Lab., North American Aviation, Inc. (Downey).

Kaszynski, Henry J., Jr., B.S. (Aero.), Materials Review Engr., Seeger Refrigerator Co.

Krasnoff, Eugene L., B. of Ae.E., Research Asst. & Student, Dept. of Mech. Engrg., Case Institute of Technology.

Krey, John F., B. of Ae.E., Jr. Engrg. Writer, Lockheed Aircraft Corp. (Burbank).

Larson, Richard E., B. of Ae.E., Engrg. Draftsman "B," North American Aviation, Inc. (Columbus).

Lehnert, Rudolf F., B.S. in Engrg., Asst. in Research, Dept. of Aeronautics, Forrestal Research Center, Princeton Univ.

MacCready, Paul B., Jr., Ph.D. (Aero.), Research Scientist, Aeronautics Dept., California Institute of Technology; Pres., Meteorology Research, Inc.

Mahone, Nelson A., Jr., B.S., Capt., U.S.A.; Staff Officer, Research & Devel., Ft. Monroe (Va.).

Majcan, Walter M., B.S.M.E. (Aero.), Jr. Engr., Aerodynamics Group, Consolidated Vultee Aircraft Corp. (San Diego).

Makofski, Robert A., B.S., Aero. Research Interne, N.A.C.A., Langley A.F.B.

Malkoun, Esther, B.S.E., Mathematician "A," Douglas Aircraft Co., Inc. (Santa Monica).

Maravich, Michael, B.S.M.E. (Aero.), Mathematician, Douglas Aircraft Co., Inc. (Santa Monica).

Martin, Robert E., B.S., Proj. Engr., Jet Propulsion Lab., California Institute of Technology.

Martinez-Rigau, Enrique, B. of Ae.E., Jr. Design Engr., Chance Vought Aircraft Div., United Aircraft Corp.

Mathieu, Richard D., B.S. in Ae.E., Grad. Student, The Pennsylvania State College.

McCaffrey, Ronald W., B. of Ae.E., Jr. Research Engr., Republic Aviation Corp.

Menzies, Donald T., B.S. in Ae.E., Stress Analyst, North American Aviation, Inc. (Downey).

Miklus, William D., B.S. in Ae.E., Jr. Engr., Design Group, Sikorsky Aircraft Div., United Aircraft Corp.

Moppert, Joseph C., Jr., Engrg. Draftsman "B," North American Aviation, Inc. (Inglewood).

Morenus, Richard C., B.M.E. (Aero.), Mathematician "A,"—Stability & Control, Douglas Aircraft Co., Inc. (Long Beach).

Noltimier, Ross L., B.S.M.E., Designer—Struct. & Mech. Equip., Trygve Hoff & Associates.

O'Connell, Raymond P., B.S.M.E. (Aero.), Engrg. Training Program, General Electric Co. (Lockland).

Odenbaugh, Richard L., B.S., Jr. Engr.-Thermodynamicist, North Amer-Colcan Aviation, Inc. (Los Angeles).

Oestreich, Charles E., B.S., 2nd Lt., U.S.A. Engrs.

Oestricher, Philip F., B. of Ae.E., Grad. Student, Aero. Engrg. Dept., Univ. of Florida.

Palmer, Harvey D., B. of Ae.E., Aero. Engr.—Guided Missile, Aerodynamics Div., Research & Devel. Labs., Hughes Aircraft Co.

Pavlosky, James E., B.S., Aerodynamicist, North American Aviation, Inc. (Columbus).

Prestjohn, Lawrence O., B.S., Designer, Staven Engrg. Co.

Pruszanowski, Olgierd C., B.S.E. in Ae.E., Grad. Student, Massachusetts Institute of Technology.

Puca, George, B. of Ae.E., 2nd Lt., U.S.A.F.; Indoctrination School, A.R.-D.C., Wright-Patterson A.F.B.

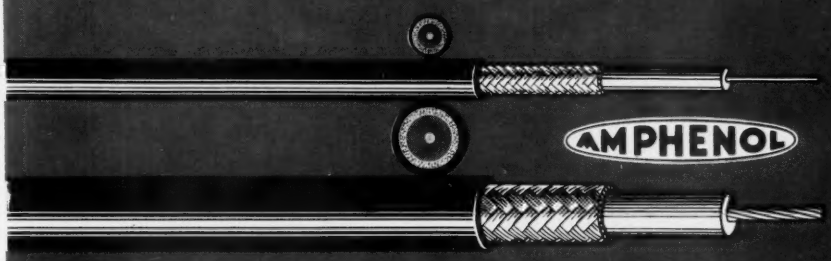
Quist, Jerome E., B.S., Jr. Engr. "C," Static Testing Dept., McDonnell Aircraft Corp. (St. Louis).

Rogers, Alden L., B. of Ae.E., Flight Test Data Analyst, Grumman Aircraft Engineering Corp.

Roof, Edwin M., B.S. in Ae.E., Draftsman—Power Plant Installation, Sikorsky Aircraft Div., United Aircraft Corp.

Roshko, Anatol, Ph.D. (Aero.), Research Fellow—Fluid Mechanics, California Institute of Technology.

RG/ coaxial cables



Whatever the size RG coaxial cable you need, you'll get a better cable when you buy from Amphenol. Every stage of cable manufacture, from the testing and selection of raw materials through to the final loading and shipping, is done by Amphenol's experienced workers in Amphenol's own modern cable plant under the watchful eye of Amphenol's technicians and engineers. There is no opportunity for outside errors to creep in.

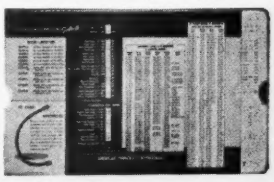
Amphenol RG coaxial cables are available with either high quality polyethylene or Teflon dielectric. The polyethylene cables are jacketed with tough, weatherproof vinyl to military specifications. The Teflon dielectric type cables have an outer covering of silicone varnish impregnated glass fibre for high temperature applications up to 500°F. These Amphenol cables satisfy every environmental need for military and civilian use from the Arctic to the Tropics.

Amphenol solid dielectric coaxial cables are providing the best in RF transmission, *without maintenance expense,* in communication service everywhere!

A few of the popular sizes of Amphenol RG / Coaxial Cables

NUMBER	AMPHENOL NUMBER	NOMINAL IMPEDANCE	NOMINAL O.D.	DIELECTRIC MATERIAL
RG-62/U	21-441	50 ohm	.160	Polyethylene
RG-58/U	21-024	53.5 ohm	.195	Polyethylene
RG-59/U	21-025	73 ohm	.242	Polyethylene
RG-63/U	21-026	93 ohm	.242	Polyethylene
RG-8/U	21-004	52 ohm	.405	Polyethylene
RG-17/U	21-013	52 ohm	.870	Polyethylene
RG-87A/U	21-250	50 ohm	.425	Teflon
[illegible]	21-382	50 ohm	.195	Teflon

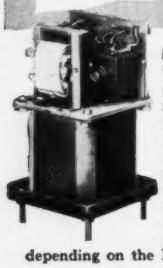
This plastic cable and connector selector is designed to help the engineer or designer to choose the proper cable or combination of cable and connector. Listed on this selector are several hundreds of cables, connectors and combinations. This handy selector will be furnished at no charge to designers and engineers working with radio frequency cables and connectors. Address your request on your company letterhead to Department 13L.



AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE • CHICAGO 50, ILLINOIS

Specified for Precision Performance!

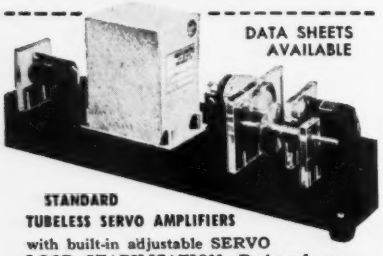
STANDARD PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS by MA



MAGNETIC AMPLIFIERS— These high gain, high performance Magnetic Amplifiers are especially suitable to drive two phase induction servo motors requiring from 0.1 watt to 20 watts per phase on either 400 cps or 60 cps powerlines. The output power is either in phase or 180 out of phase with the powerline depending on the D.C. input signal polarity.

SATURABLE TRANSFORMERS, REACTORS

Lower power gain, Magnetic Amplifiers designed to drive two phase induction motors. Output powers available are from 0.5 watt to 1000 watts, 400 or 60 cps. Catalog available.



DATA SHEETS AVAILABLE

STANDARD TUBELESS SERVO AMPLIFIERS with built-in adjustable SERVO LOOP STABILIZATION. Packaged, completely self-contained, magnetic servo amplifiers for position servo systems where either A.C. or D.C. error signals are available. Designed for instrument type and power type servo systems to work with synchro control transformers or potentiometers and two phase induction servo motors.

Facilities Know-How to Engineer Design and Manufacture MAGNETIC SERVO AMPLIFIERS, VARIABLE SPEED DRIVES, MAGNETIC VOLTAGE, CURRENT FREQUENCY REGULATORS

Where the standard units do not meet your requirements our engineering facilities are available to work with you on overall system design.

MAGNETIC AMPLIFIERS • INC

An Affiliate of General Ceramics & Steatite Corp.

632 TINTON AVE., NEW YORK 55, N. Y.

Telephone: CYPRESS 2-6610

Russell, William R.

Saviano, Ralph F., B. of Ae.E., Aerodynamicist "C," North American Aviation, Inc. (Los Angeles).

Shepherd, James D., Struct. Engr. "C," McDonnell Aircraft Corp.

Spak, Michael, B.S. in Ae.E., Jr. Engr., Douglas Aircraft Co., Inc. (El Segundo).

Stanley, Paul P., B.S. in Ceramic Engrg., Capt. & Pilot, U.S.A.F.; Proj. Engr., Ceramic Unit, Aero. Div., A.D.C., Wright-Patterson A.F.B.

Stiebling, Mary Lou, B.S. in Ae.E., Engrg. Asst. "A," Aerodynamics Sect., Northrop Aircraft, Inc.

Swimley, Malcolm B., Jr. Engr., Guided Missile Div., Consolidated Vultee Aircraft Corp. (Pomona).

Talbot, Lawrence, Ph.D., Asst. Prof., Mech. Engrg. Div., Univ. of California.

Tangler, Howard, B.S. in Ae.E., Static Test Engr., Douglas Aircraft Co., Inc. (El Segundo).

Tillson, Richard L., Aerodynamicist, North American Aviation, Inc. (Los Angeles).

Vance, Harold C., Jr., B. of Ae.E., Grad. Student & Teaching Asst., Rensselaer Polytechnic Institute.

Vas, Irwin E., B.M.E., Student-Research Asst., Princeton Univ.

Weber, John F., B.S.M.E. (Aero.), Lt. & Naval Aviator, U.S.N. (Washington, D.C.).

Wilvert, Willard E., Capt., U.S.A.F.; Proj. Engr., Wright-Patterson A.F.B.

Changes of Address

Since the Post Office Department does not as a rule forward magazines to forwarding addresses, it is important that the Institute be notified of changes in address 30 days in advance of publishing date to ensure receipt of every issue of the *Journal* and *Review*.

Notices should be sent directly to:

Institute of the Aeronautical Sciences

2 East 64th Street

New York 21, N.Y.

AIRSURANCE

Airline Passenger Insurance

Annual Policies from $5,000 to $100,000 at new low rates

No Physical Examination • No Age Limit

EXAMPLE

$25,000.00 for death or dismemberment
$1,000.00 for Hospital and Doctor's bills
$50.00 per week when disabled

PREMIUM $38.00 per year

Policies cover passengers on scheduled airlines world-wide — also airlines in Canada, Mexico and South America which meet safe operating standards.

Backed by the Combined Assets of

Aetna Casualty & Surety Co.
American Surety Co. of N. Y.
Century Indemnity Company
Hartford Accident & Indemnity Co.
Maryland Casualty Co.
Massachusetts Bonding & Insurance Co.
New Amsterdam Casualty Co.
Standard Accident Insurance Company
Travelers Insurance Co.
United States Casualty Co.
United States Fidelity & Guaranty Co.

U.S.GROUP

WRITE OR PHONE ANY U. S. GROUP OFFICE

UNITED STATES AVIATION UNDERWRITERS INCORPORATED

80 JOHN ST. • NEW YORK 38, N. Y.

ATLANTA • CHICAGO • DALLAS • KANSAS CITY

LOS ANGELES • SAN FRANCISCO

For Dependable Hose Connections

WITTEK STAINLESS STEEL *Aviation* HOSE CLAMPS

TYPE WWD (Tangential—with one-piece housing)

TYPE FBSS (Radial—with floating bridge)

Conform to Navy & Air Force Specifications—C.A.A. Approved

WITTEK Manufacturing Co.

4305-15 West 24th Place, Chicago 23, Illinois

THE COUNTRY'S **LARGEST** EXTRUSION PRESS...

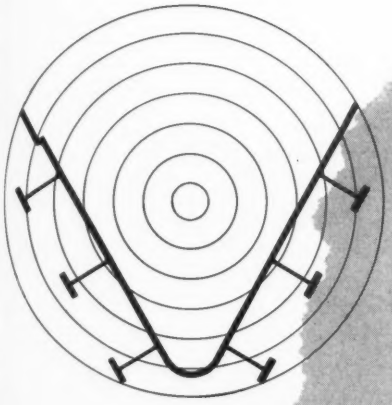
now being installed by Alcoa...

increases maximum extrusion size

from a 15-inch to a 23-inch

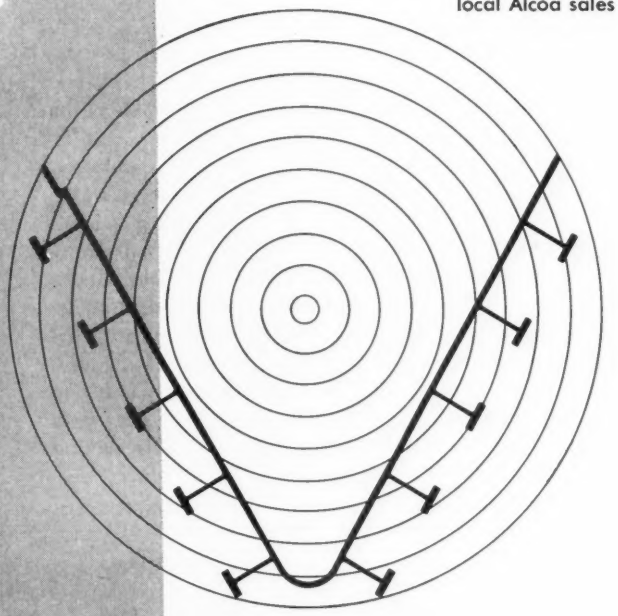
circumscribing circle, or from 600 pounds

to 2300 pounds per piece



The 13,200-ton squeeze of this press means that Alcoa extrusions can be larger, thinner, and more intricate than before. Ribbed extrusions for panels, for example, can be made, as illustrated, 34 inches wide—saving greatly in riveting and assembly.

For complete information call your local Alcoa sales engineer.



ALCOA

ALUMINUM COMPANY OF AMERICA

1801-M GULF BUILDING, PITTSBURGH 19, PA.

Eclipse-Pioneer . . . as the world's largest producer of aviation instruments and accessories . . . naturally assumed major responsibility in meeting the accelerated demand that instantly followed Korea. The tremendous new task we faced was two-fold. First, to multiply productive capacity . . . and to do it quickly. Second, to handle an over-all production job vastly more complex than any ever experienced before. The record of the past 30 months tells its own story of accomplishment—2 new manufacturing divisions created, 23 complete unit sub-contractors added, a network of over 2300 parts sub-contractors established. And, as the final criterion, a production output expanded to 514% of our pre-Korea level. As of today, we are geared to deliver the goods in a majority of products . . . and are making substantial progress daily in catching up with the balance.

WORLD'S LARGEST PRODUCER OF AVIATION INSTRUMENTS AND ACCESSORIES

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Precision Products* Made by Eclipse-Pio

- Automatic Pilot and Fli Control Equipment
- Airplane and Engine I
- Flight and Navigation I
- Power Supply Equipme
- Air Pressurization and I Elimination Equipment
- Engine Starting Equipme
- Oxygen Equipment
- Precision Components f Servomechanism and C Equipment
- Sand, Permanent Mold Castings of Magnesium Aluminum
- Plaster Mold Castings

*Manufacturing capacity is available for a great models of these p

Eclipse-Pioneer

DIVISION OF Bendix AVIATION CORPORATION

TETERBORO, NEW JERSEY

Aeronautical Reviews

A Guide to the Current Literature of Aeronautical Research and Engineering

I. PERIODICALS AND REPORTS

The abstracts are classified according to the Air Technical Index Distribution Guide. Numbers in parentheses indicate the position of the Division Headings in the numerical arrangement.

Aerodynamics (2)
- Fluid Mechanics and Aerodynamic Theory ... 71
- Internal Flow ... 71
- Wings & Airfoils ... 72

Aeroelasticity ... 72

Air Transportation (41) ... 74

Airplane Design (10) ... 74
- Airplane Descriptions ... 74
- Landing Gear ... 74
- Operation & Performance ... 74
- Wing Group ... 76

Aviation Medicine (19) ... 76

Education & Training (38)
- Flight Training ... 76

Electronics (3)
- Antennas ... 76
- Circuits & Components ... 76
- Electronic Tubes ... 76
- Extraterrestrial Phenomena ... 76
- Measurements & Testing ... 76
- Navigation Aids ... 76
- Noise & Interference ... 76

Flight Safety & Rescue (15) ... 78

Fuels & Lubricants (12) ... 78

Instruments (9) ... 78

Lighter-Than-Air (40) ... 81

Machine Elements (14)
- Fastenings ... 81

Maintenance (25) ... 81

Materials (8)
- Corrosion & Protective Coatings ... 81
- Metals & Alloys ... 81
- Nonmetallic Materials ... 82

Meteorology (30) ... 82

Military Aviation (24) ... 85

Missiles (1) ... 85

Parachutes ... 85

Photography (26) ... 85

Power Plants ... 85
- Jet & Turbine (5) ... 85
- Ram-Jet & Pulse-Jet ... 85
- Reciprocating (6) ... 85
- Rocket (4) ... 85

Production (36) ... 86

Reference Works (47) ... 86

Rotating Wing Aircraft (34) ... 86

Sciences, General (33)
- Mathematics ... 86

Structures (7) ... 88

Thermodynamics (18) ... 90

Water-Borne Aircraft (21) ... 90

Wind Tunnels & Research Facilities ... 90

II. BOOKS REVIEWED IN THIS ISSUE

Book Notes ... **93**

Books, reports, and periodicals reviewed in this issue or in previous issues may be borrowed on 2-week loan without charge by individual or Corporate Members of the Institute in the U.S. and Canada. Members of The Paul Kollsman Lending Library who are not Members of the Institute may borrow books and, in special cases, other research material. Members of the I.A.S. may borrow also from the Engineering Societies Library through The Paul Kollsman Lending Library.

Photostatic copies of material in the Institute's libraries may be obtained at a cost of $0.30 to members and Corporate Members ($0.40 to nonmembers) for each 8 1/2- by 11-in. print and $0.35 to members and Corporate Members ($0.45 to nonmembers) for each 11 1/2- by 14-in. print, plus postage. A service charge of $1.00 is made to nonmembers of the I.A.S. Rates for *microfilm copies* will be sent on request.

Bibliographies on special subjects will be compiled at the rate of $2.50 per hour. *Translations* of technical literature from foreign languages may be obtained at $12 to $14 per 1,000 words, depending on the language. I.A.S. members receive a 20 per cent discount on bibliographies and translations.

Full information about library membership and facilities will be sent upon request to The Paul Kollsman Lending Library, 2 East 64th St., New York 21, N.Y.

Heating elements embedded in Silastic are used to prevent icing of air intake doors on jet engines.
In diesel-electric locomotives, Silastic gaskets for cylinder liners, water ports and oil pans, eliminate major overhauls previously caused by premature failure of organic rubber seals.
In spite of hot oil and long exposure to temperatures ranging from below zero to 400-450 F., Silastic spark plug boots exclude moisture; make automobile engines easy to start on wet mornings.

Silastic* works where ordinary rubber fails

At temperatures from −100° to over 500° F.,
in contact with hot oil at 350-400° F.,
in spite of weather, corona, shock and vibration,
you can count on Silastic to maintain a tight seal
or to confine electricity at high or low voltages.
That's proved by the fact that Silastic is used
to insulate traction motors, Navy control cable and
ignition cable for aircraft and ordnance vehicles.
It's used to seal heating and deicing systems,
bomb bay doors, limit control switches
and rocker box covers on aircraft;
sole plates in domestic steam irons;
cylinder liners and water ports in
diesel-electric locomotive engines.

For more information, mail this coupon today.

DOW CORNING CORPORATION
Dept. No. A—24, Midland, Michigan
Please send me
☐ Silastic Facts No. 10 on properties and performance
☐ List of Silastic Fabricators
Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

DOW CORNING CORPORATION
DOW CORNING SILICONES
MIDLAND, MICH.
ATLANTA
CHICAGO
CLEVELAND
DALLAS
NEW YORK
LOS ANGELES
WASHINGTON, D. C.
In Canada: Fiberglas Canada Ltd., Toronto
In England: Midland Silicones Ltd., London

*T.M. Reg. U.S. Pat. Off.

Aerodynamics (2)

BOUNDARY LAYER AND THERMOAERODYNAMICS

On Heat Transfer over a Sweat-Cooled Surface in Laminar Compressible Flow with a Pressure Gradient. Morris Morduchow. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 705–712, illus. 10 references.

Derivation of an expression, based on a Prandtl Number of unity and on the assumption that the viscosity coefficient varies linearly with the temperature, and with validity for any given free-stream Mach Number, for the normal injection velocity distribution theoretically required to maintain a given uniform temperature along a porous surface in the laminar boundary-layer region of a compressible flow with a given velocity distribution outside of the boundary layer. Dorodnitsyn-type transformation is used to take into account the variation of fluid properties. The analytic method consists of applying the Kármán-Pohlhausen technique to both the energy and momentum boundary-layer equations for compressible flow and of using an additional heat balance equation involving the coolant temperature; a closed-form approximate solution of the equations is derived; numerical examples.

Readers' Forum: Direct Measurement of Supersonic Skin Friction. Donald Coles. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, p. 717, illus. 1 reference.

Preliminary Survey of Boundary-Layer Development at a Nominal Mach Number of 5.5. Harold L. Bloom. *U.S., N.A.C.A., Research Memorandum No. E52D03*, June 18, 1952. 26 pp., illus. 7 references.

Measurements of mean skin-friction coefficients on a flat-plate model, with and without initial roughness, and on a wind-tunnel wall at a nominal Mach Number of 5.5 over a Reynolds Number range from 1×10^6 to 1×10^7; comparison with analytical values.

FLUID MECHANICS & AERODYNAMIC THEORY

A Mixing Theory for the Interaction Between Dissipative Flows and Nearly Isentropic Streams. Luigi Crocco and Lester Lees. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 649–676, illus. 22 references.

A theoretical analysis of the concept of the transport of momentum from outer stream to dissipative flow (turbulent "mixing" or laminar diffusion) considered as the fundamental physical process determining the pressure rise that can be supported by the flow. The phenomena in fluid mechanics treating of the interaction between a viscous or dissipative flow near the surface of a solid body, or in its wake, and an "outer" nearly isentropic stream with varying static pressure may be observed in all types of boundary-layer-shock-wave interactions that are of importance in flow problems; application to the base pressure problem in plane supersonic flow; the statement of a "simplified" mixing theory for separated and reattaching flows and wakes.

The Problem of Drag. F. Riegels. *Interavia*, Vol. 7, No. 8, August, 1952, pp. 451–454, illus. 1 reference. A summary of knowledge about the laws of drag as applied to the behavior of a body in incompressible and compressible flow.

Note on a Sufficient Condition for the Stability of General, Plane Parallel Flows. Martin Lessen. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 184–186. 3 references.

Derivation of sufficient conditions similar to those derived by Synge for the stability of plane Couette motion and plane Poiseuille motion, for any parallel flow with either finite or infinite boundary conditions or both.

Readers' Forum: On Theodorsen Function in Incompressible Flow and C-Function in Supersonic Flow. Chieh-Chien Chang. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 717, 718, illus. 7 references.

Laminar-Turbulent Transition in Smooth Tubes. R. R. Rothfus and R. S. Prengle. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1683–1688, illus. 14 references.

Readers' Forum: Remarks on "An Analytical Approach to the Fuel Sloshing and Buffeting Problems of Aircraft" by Harold Luskin and Ellis Lapin. M. Z. Krzywoblocki. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 715, 716. 6 references.

A Note on the Hodograph Transformation. A. R. Manwell. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 177–184, illus. 9 references. Development of a theorem that allows the detailed examination of flows with simple hodographs.

Diffusion of Heat from a Line Source in Isotropic Turbulence. Mahinder S. Uberoi and Stanley Corrsin. *U.S., N.A.C.A., Technical Note No. 2710*, June, 1952. 90 pp., illus. 31 references.

An experimental and analytical study of some features of the turbulent heat diffusion behind a line-heated wire stretched perpendicular to a flowing isotropic turbulence; mean-temperature-distribution measurements with systematic variation in wind speed, size of turbulence-producing grid, and downstream location of heat source. A comparison of Lagrangian and Eulerian analyses for diffusion in nondecaying turbulence yields an expression for turbulent-heat-transfer coefficient in terms of turbulent velocity and a Lagrangian scale. A convenient form is deduced for the criterion of interchangeability of instantaneous space and time derivatives in a flowing turbulence.

Generalization of a Problem of Rayleigh. Stanley Corrsin. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 186–189. 3 references.

Development of a solution, for a compressible fluid, of Rayleigh's problem of the incompressible viscous flow set up by an infinite plate suddenly moved at constant velocity in its own plane.

Temperature Gradients in Turbulent Gas Streams; Methods and Apparatus for Flow Between Parallel Plates. W. H. Corcoran, F. Page, Jr., W. G. Schlinger, and B. H. Sage. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 410–419, illus. 25 references.

(Temperature Gradients in Turbulent Gas Streams); Temperature and Velocity Distributions in Uniform Flow Between Parallel Plates. F. Page, Jr., W. H. Corcoran, W. G. Schlinger, and B. H. Sage. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 419–424, illus. 23 references.

(Temperature Gradients in Turbulent Gas Streams); Point Values of Eddy Conductivity and Viscosity in Uniform Flow Between Parallel Plates. F. Page, Jr., W. G. Schlinger, D. K. Breaux, and B. H. Sage. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 424–430, illus. 21 references.

Readers' Forum: Transonic Flow Past a Wedge with Detached Shock Wave. A. H. Armstrong, M. Holt, and C. K. Thornhill. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, p. 715, illus. 3 references.

Readers' Forum: On Folds Occurring in the Mapping from the Physical Plane to the Hodograph Plane. Keith C. Harder and E. B. Klunker. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, p. 719, illus.

The Pitot Cylinder as a Static Pressure Probe in Turbulent Flow. A. H. Glaser. *Journal of Scientific Instruments*, Vol. 29, No. 7, July, 1952, pp. 219–221, illus. 5 references.

Construction, aerodynamic properties, and results of wind-tunnel and atmospheric tests of a simple static pressure probe, in the form of a long cylinder with two radial holes separated by a critical angular distance, which gives accurate results in a fixed position in a natural wind of rapidly varying direction and speed.

INTERNAL FLOW

Readers' Forum: On the Lift and Circulation of Airfoils in Some Unsteady-Flow Problems. Nelson H. Kemp. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 712, 713, illus. 4 references.

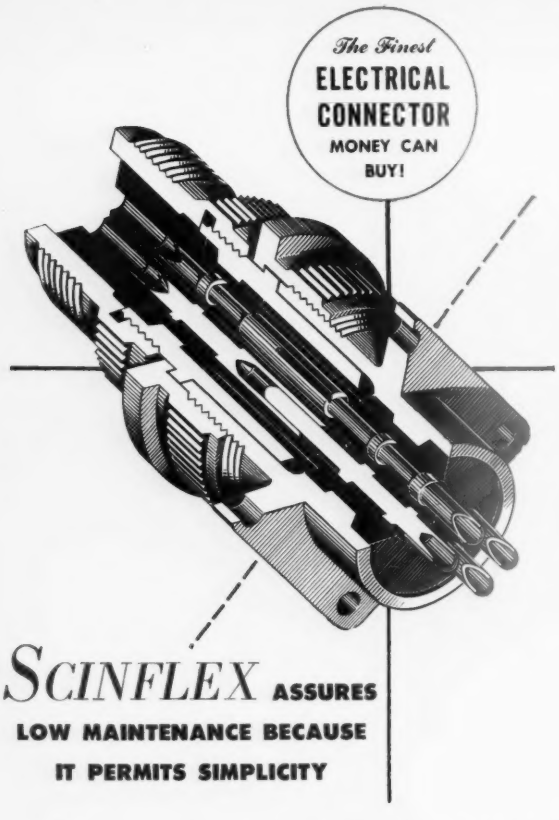
Axially Symmetrical Jet Mixing of a Compressible Fluid. S. I. Pai. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 141–148, illus. 12 references.

Development of a solution for both the laminar and turbulent cases of an axially symmetrical jet of a compressible fluid exhausting into a uniform stream which assumes the pressure of the flow at the exit to be exactly equal to that of the surrounding stream and the pressure gradient in the jet to be negligible.

Readers' Forum: Supersonic Nozzles with Continuous Wall Curvature. R. C. Frost and H. P. Liepman. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, p. 716, illus. 4 references.

Letter to the Editor: The Critical Flow of Gases Through Nozzles. B. Szczeniowski. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 177, 178, illus. 12 references.

Development of a general solution for the critical flow of gases through nozzles which does not assume viscosity and avoids assumptions about the nature of the adiabatic process.



SCINFLEX ASSURES
LOW MAINTENANCE BECAUSE
IT PERMITS SIMPLICITY

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX
ELECTRICAL CONNECTORS

Bendix

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.
FACTORY BRANCH OFFICES: 118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

WINGS & AIRFOILS

Readers' Forum: On the Lift and Circulation of Airfoils in Some Unsteady-Flow Problems. Nelson H. Kemp. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 712, 713, illus. 4 references.

Wind Tunnel Investigations on Rotating Blades of Aerofoil Section. K. H. Khalil. *The Engineer*, Vol. 194, No. 5038, August 15, 1952, pp. 221–223, illus.

Investigations on the pressure distributions around airfoil section blades rotating in a wind tunnel; experimental technique and procedure. Contrast between rotating and static conditions indicates the similarity in the pressure diagram shapes and the significance of the spin factor; discussion of results.

A Second-Order Solution for an Oscillating Two-Dimensional Supersonic Airfoil. Alexander Wylly. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 685–696, 704, illus. 15 references.

Development, by means of an iteration procedure, of a second-order solution for an oscillating two-dimensional supersonic airfoil to include the higher-order terms in angle of attack and thickness in order that the relative importance of second-order terms and tendencies indicated by them may be evaluated. A linearized (or first-order) velocity potential, of suitable form for use in the iteration procedure, is developed as a power series approximation, in frequency, to the exact linearized solution.

Inviscid Flow About Airfoils at High Supersonic Speeds. A. J. Eggers, Jr., and Clarence A. Syvertson. *U.S., N.A.C.A., Technical Note No. 2646*, March, 1952. 65 pp., illus. 20 references.

Analytic investigation of flow about curved airfoils at high supersonic speeds in which the method of characteristics is used to obtain accurately flow fields and more approximate methods of analysis; application of the method in a generalized form that allows caloric imperfections as well as entropy gradients in the flow to be considered at temperatures up to the order of 5,000°R. The method is applied to a 10-per-cent-thick biconvex airfoil at Mach Numbers from 3.5 to infinity; comparison of results with the predictions of the shock-expansion method.

Why British Push the Delta Wing Design. David A. Anderton. *Aviation Week*, Vol. 57, No. 12, September 22, 1952, pp. 22–25, 27, 28, 30, illus. Aerodynamic requirements and manufacturing problems solved by delta-wing aircraft; construction and performance of delta-wing aircraft shown at Farnborough.

Aeroelasticity

A Second-Order Solution for an Oscillating Two-Dimensional Supersonic Airfoil. Alexander Wylly. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 685–696, 704, illus. 15 references.

Development, by means of an iteration procedure, of a second-order solution for an oscillating two-dimensional supersonic airfoil to include the higher-order terms in angle of attack and thickness in order that the relative importance of second-order terms and tendencies indicated by them may be evaluated. A linearized (or first-order) velocity potential, of suitable form for use in the iteration procedure, is developed as a power series approximation, in frequency, to the exact linearized solution.

The Quarter-Infinite Wing Oscillating at Supersonic Speeds. Theodore R. Goodman. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 189–192, illus. 8 references.

Development of an independent solution, based on the method of C. S. Gardner, for the problem of the quarter-infinite wing oscillating at supersonic speeds which agrees with results reached by J. W. Miles and K. Stewartson.

Readers' Forum: Radii of Gyration of Aircraft. J. P. Chawla. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 718, 719. 2 references.

Readers' Forum: Determination of Modes and Frequencies Above the Fundamental by Matrix Iteration. P. Cicala. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 719, 720. 2 references.

Readers' Forum: Remarks on "An Analytical Approach to the Fuel Sloshing and Buffeting Problems of Aircraft" by Harold Luskin and Ellis Lapin. M. Z. Krzywoblocki. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 715, 716. 6 references.

POWER

EEMCO

technical bulletin

WEIGHT

POWER

Greater output per pound is the constant objective of the aircraft designer. EEMCO serves this goal by turning out new electric motors with increased power, decreased weight and all the required operating characteristics. This tough new lightweight for driving a compressor was built to the latest Army and Navy specifications. Operating on 27 volts D.C., it provides 3 horsepower under continuous duty at sea level, 2½ h.p. at 50,000 feet with duty cycle of ½ hour on—½ hour off. It weighs only 13½ pounds with integral gear box of 2¾ to 1 reduction.

Doubled plant capacity and new facilities enable EEMCO to keep pace with the growing need for these specialized designs. Today EEMCO motors and actuators are found on virtually all U. S. Aircraft.

WEIGHT

ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard
Los Angeles 16, California

3-514

Air Transportation (41)

Civil Aircraft Registration in the USSR. Denys J. Voaden. *Aeronautics*, Vol. 26, No. 6, July, 1952, pp. 44, 45. Information about Russian civil aviation interpreted from aircraft registration letters.

Where Are America's Jet Transports? I, II, III. *Interavia*, Vol. 7, Nos. 6, 8, 9, June, August, September, 1952, pp. 312, 313; 446; 492–494, illus. 1 reference. Problems and prospects in the financing of prototype jet transport aircraft in the U.S.; probable costs; plans for subsidies.

World Air Transport in Perspective; Interview with Sir William P. Hildred, Director General, International Air Transport Association (I.A.T.A.). *American Aviation*, Vol. 16, No. 8, September 15, 1952, pp. 24, 25, 28, 31, 32. Information on I.A.T.A.'s system of enforcing passenger transport regulations, cargo traffic expectancy, and various world air transport problems.

Transport Problems 1952. Partial Contents: The DC-3's Successors. Britain's Civil Aviation Policy. *Interavia*, Vol. 7, No. 9, September, 1952, pp. 479–495, illus.

U.S. Airlines in 1951. *Interavia*, Vol. 7, No. 7, July, 1952, pp. 400, 401. 2 references.

Summary of the A.T.A.'s report for 1951 on developments in U.S. scheduled air transport; tables give traffic statistics, earning records, and operating expenses of U.S. domestic and international airlines.

Philippine: Carrier That Returned. George L. Christian. *Aviation Week*, Vol. 57, No. 10, September 8, 1952, pp. 62, 64, 66–68, 71, 72, 75, illus. Postwar maintenance and operations record of the Philippine Air Lines; aircraft in use and services they perform; future plans.

TPA Aloha: The Fly-by-Day Airline. George L. Christian. *Aviation Week*, Vol. 57, No. 12, September 22, 1952, pp. 53, 54, 57, 59, illus. Operating and maintenance methods and safety and revenue records of Trans-Pacific Airlines, Ltd.; method of preventing "no-shows."

Transocean: "Anything, Anywhere" Airline. George L. Christian. *Aviation Week*, Vol. 57, No. 11, September 15, 1952, pp. 55, 56, 58, 60, 63, illus. Activities of Transocean Air Lines and its subsidiaries; number and types of aircraft operated; transport, freight, and other services; aircraft-safety research.

Airplane Design (10)

Notes on the Power-Speed-Weight Relationship for Vehicles. K. S. M. Davidson. *Stevens Institute of Technology, Experimental Towing Tank, Technical Memorandum No. 97*, January, 1951. 65 pp., illus. 3 references.

Preliminary form of an analytic method that includes within a single frame of reference the relative power-speed-weight potentialities and limitations of widely varying types of vehicles, with emphasis on air-borne and water-borne transports; comparison with the Gabrielli-von Kármán limit line.

AIRPLANE DESCRIPTIONS

Experimental Evolution. Derek Wood. *Aeronautics*, Vol. 26, No. 6, July, 1952, pp. 24–26, illus. Construction and application of some little-known experimental aircraft developed for special purposes during World War II.

Short-Life Aircraft. Partial Contents: The West Turns Out Its Pockets. Pierre M. Gallois. Germany's "De-Refinement Programme." A. Eschenauer. Just Why Are Aircraft So Costly? *Interavia*, Vol. 7, No. 7, July, 1952, pp. 363–382, illus. 1 reference.

Where Are America's Jet Transports? I, II, III. *Interavia*, Vol. 7, Nos. 6, 8, 9, June, August, September, 1952, pp. 312, 313; 446; 492–494, illus. 1 reference.

Design features and expected performance of prototype jet transport aircraft under consideration for production by several American aircraft companies.

Family Resemblance in Jet Fighters. Hans E. Quenzer. *Interavia*, Vol. 7, No. 7, July, 1952, pp. 388, 389, illus. 1 reference. History and features of the Focke-Wulf Ta 183 design; its probable influence on the Russian MiG-15 and on the fighter aircraft of other countries.

René Leduc's Ramjets. *Interavia*, Vol. 7, No. 6, June, 1952, p. 341, illus. Characteristics and performance; flight-test progress.

The DC-3's Successors. *Interavia*, Vol. 7, No. 9, September, 1952, pp. 486–491, illus.

Problems in the replacement of the DC-3; a table gives calculations of the operating costs for the Sikorsky S-55 and for four other types: Douglas DC-3, Convair-Liner 240, de Havilland Heron, and Type X, a hypothetical type with 1,500 h.p. engines, corresponding roughly to the Super DC-3 as well as to the 32-seat Saab Scandia and the Canadair CL-21.

Fokker. Henk A. Jansen. *Pegasus*, Vol. 19, No. 3, September, 1952, pp. 9–11, illus. History and evolution of the Fokker Aircraft Company; development of aircraft designs ranging from the World War I Fokker D-VII fighter to the 1952 S-14 two-place jet trainer.

Why British Push the Delta Wing Design. David A. Anderton. *Aviation Week*, Vol. 57, No. 12, September 22, 1952, pp. 22–25, 27, 28, 30, illus. Construction and performance of delta-wing aircraft shown at Farnborough; aerodynamic requirements and manufacturing problems solved by this aircraft type.

The S.B.A.C. Flying Display and Static Exhibition. I, II, III. *The Engineer*, Vol. 194, Nos. 5041, 5042, 5043, September 5, 12, 19, 1952, pp. 325, 326; 355, 356; 376–379, illus.

Farnborough Review. *Flight*, Vol. 62, Nos. 2276, 2277, September 5, 12, 1952, pp. 306–312; 353–364, illus. Construction and performance of military and civil aircraft, helicopters, power plants, guided missiles and targets, and aircraft components and accessories exhibited at Farnborough.

Summing Up the Show. *The Aeroplane*, Vol. 83, No. 2147, September 12, 1952, pp. 382–412, illus. Military and civil aircraft, helicopters, power plants, and other aircraft components and equipment shown at the S.B.A.C. Farnborough exhibit.

Blackburn and General Mk 2 Four-Engined Universal Freighter Aircraft, England. *Flight*, Vol. 62, No. 2274, August 22, 1952, pp. 218, 219, illus., cutaway drawing.

Boeing YB-52 Strato-Fortress Eight-Engined Turbojet Bomber Aircraft. *Aviation Week*, Vol. 57, No. 7, August 18, 1952, pp. 12–17, illus.

Boeing YB-52 Stratofortress and Convair YB-60 Swept-Wing Eight-Engined Turbojet Bomber Aircraft. *Interavia*, Vol. 7, No. 6, June, 1952, p. 308, illus.

Bristol 175 Britannia Four-Engined Turboprop Transport Aircraft, England. *Flight*, Vol. 62, No. 2274, August 22, 1952, pp. 209–214, illus., cutaway drawing.

de Havilland D.H. 106 Comet Four-Engined Turbojet Transport Aircraft, England. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 310–312, illus.

de Havilland D.H. 110 Swept-Wing Twin-Engined Jet Fighter Aircraft, England. *Aviation Week*, Vol. 57, No. 11, September 15, 1952, pp. 21–23, 25, 26, 29, 30, 33, illus. Development, structural features, and performance; table gives specifications and performance of the vampire series and the D.H. 108.

Heinkel HE 162 Turbo-Jet Fighter Aircraft, Germany. Ernst Heinkel. *Interavia*, Vol. 7, No. 7, July, 1952, pp. 372–375, illus.

Hurel-Dubois H.D. 31 Twin-Engined Transport Aircraft, France. *Aviation Week*, Vol. 57, No. 10, September 8, 1952, pp. 21, 22, 25, 26, 29, illus. High aspect ratio cuts H.D. 31 drag, with power gain and fuel economy.

MiG-15 Single-Engined Turbojet Fighter Aircraft, U.S.S.R. *The Aeroplane*, Vol. 83, No. 2141, August 1, 1952, pp. 160–162, illus.

Saab 210 Draken Single-Engined Turbojet Delta-Wing Experimental Research Aircraft, Sweden. The Aeroplane, Vol. 83, No. 2146, September 5, 1952, p. 349, illus.

Scottish Aviation Pioneer 4 Twin-Engined Transport Aircraft, Scotland. *The Aeroplane*, Vol. 83, No. 2146, September 5, 1952, pp. 367, 368, illus.

LANDING GEAR

Drop Testing Aircraft. Morris Isaac. *Quadrangle*, Vol. 22, No. 6, May, 1952, pp. 15–17, 46, illus. Equipment and techniques used for drop-testing aircraft to determine strength and structural design faults of the landing gear.

OPERATION & PERFORMANCE

Bristol 175 Britannia Four-Engined Turboprop Transport Aircraft, England. *The Engineer*, Vol. 194, No. 5039, August 22, 1952, p. 264, illus. The maiden flight performance.

For the Answer to Your Insulation Problem

Look Through *this* Line...

● Can't guarantee that the Varflex Line will solve every insulation problem. But . . . Many's the problem—large, small, unusual—that Varflex Electrical Sleeving or Tubing has solved. The Varflex range of application is vast—chances are you'll find the solution to your Electrical insulating problem somewhere in the Varflex line.

- **VARGLAS SILICONE.** That's the insulating sleeving and tubing—pioneered by Varflex—that takes temperatures ranging from 500° F above to 85° F below in its efficient, resistant stride. Lead wire and treated cord too.
- **VARGLAS TUBING IMPREGNATED WITH GENERAL ELECTRIC PERMAFIL.** Tough, flexible, heat-resistant—available in coils. Premium tubing at a reasonable price.
- **VARGLAS SLEEVING AND TUBING.** Numerous types and grades—including synthetic treated, varnished, lacquered, saturated, litewall and others.
- **VARGLAS NON-FRAY SLEEVING.** Three types—may be subjected to temperatures up to 1200° F—for applications where dielectric requirements are not primary.
- **VARFLO TUBING AND SLEEVING.** New, low-priced — for applications where unusually high temperatures are not a factor. A real economy line, this.
- **VARFLEX COTTON TUBING AND SLEEVING.** Varnish or lacquer impregnants — for applications where Fiberglas products are not required.
- **SYNTHOLVAR EXTRUDED PLASTIC TUBING.** Low temperature flexibility—high dielectric and tensile strength—made from a standard formulation of vinyl polymers.

SAMPLES? All you want with our compliments. For free folder of our complete line, just clip and mail this coupon.

VARFLEX CORPORATION

MAKERS OF ELECTRICAL INSULATING TUBING AND SLEEVING

VARFLEX Corporation, 311 Jay St., Rome, N. Y.

Please send me information as well as free samples of your electrical Sleeving and Tubing.

I am particularly interested in samples suitable for.....

Name.....

Company.....

Street.....

City.....Zone.....State.....

WING GROUP

Complete Wing Tests on the "Britannia" Airliner. *The Engineer*, Vol. 194, No. 5037, August 8, 1952, pp. 189, 190, illus. Structural tests on a complete wing with a brief description of the test frame used.

Aviation Medicine (19)

World's Largest Centrifuge Tests Men & Equipment. *Tele-Tech*, Vol. 11, No. 7, July, 1952, pp. 42, 43, illus. Instrumentation and layout of the centrifuge, at the Naval Air Development Center at Johnsville, Pa., in which men and communications equipment can be accelerated to 40 G at 48.6 r.p.m. in 6.8 sec.

Education & Training (38)

FLIGHT TRAINING

Canberra Conversion Unit at Work. *The Aeroplane*, Vol. 83, No. 2146, September 5, 1952, pp. 364–366, illus. Equipment and simulated flight techniques used at a British operational conversion unit for training Canberra crews.

Electronics (3)

ANTENNAS

The Radiation Pattern of an Antenna over a Circular Ground Screen. James E. Storer. *Journal of Applied Physics*, Vol. 23, No. 5, May, 1952, pp. 588–593, illus. 6 references.

Derivation of simple expressions for the change of radiation pattern of an antenna of unrestricted length erected over a large circular screen as a function of the diameter of the screen.

Electromagnetic Back-Scattering from Cylindrical Wires. C. T. Tai. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 909–916, illus. 8 references.

Investigation of electromagnetic back-scattering or radar response from perfectly conducting cylindrical wires using a variational method; comparison of results with those of the e.m.f. and the integral equation methods; application of the variational method to the problem of broadside incidence.

Evaluation of Unidirectional Antennas for 450–460 Mc. J. S. Brown. *Tele-Tech*, Vol. 11, No. 7, July, 1952, pp. 48, 49, 90, 92, illus.

CIRCUITS & COMPONENTS

A Mathematical Analysis of a Dielectric Amplifier. Louis A. Pipes. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 818–824, illus. 14 references.

A mathematical analysis of the fundamental circuit for dielectric amplifiers which assumes that the effective hysteresis curve of the amplifier's dielectric material may be represented by a hyperbolic sine function; analysis for the case of resistive load; derivation of expressions for the steady-state input and output currents. An estimate of the time constant of the amplifier is obtained from an analysis of its transient response.

Stabilization of Dielectrics Operating Under Direct Current Potential. H. A. Sauer, D. A. McLean, and L. Egerton. *Industrial and Engineering Chemistry*, Vol. 44, No. 1, January, 1952, pp. 135–140, illus. 15 references.

Mode Interactions in Magnetrons. R. R. Moats. *Tele-Tech*, Vol. 11, No. 7, July, 1952, pp. 39–41, 78, 88, illus. An analysis of the problems of mode selection in pulse magnetrons and of mode stability in either pulse or continuous wave operation.

Novel Design Featured in HF Transceiver. Philip Klass. *Aviation Week*, Vol. 57, No. 11, September 15, 1952, p. 48, illus.

Construction, operation, and advantages of Collins Radio Co.'s 618S 100-watt high-frequency air-borne transceiver that can be used with telephone or continuous wave in the 2-to-25-mc. band and provides up to 144 crystal-controlled channels, with a minimum of 129 independent frequencies.

The Transfer Function of General Two Terminal-Pair RC Networks. Aaron Fialkow and Irving Gerst. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 113–127, illus. 7 references.

Transistors: Summary of Progress in Performance. *Tele-Tech*, Vol. 11, No. 7, July, 1952, pp. 36–38, 102–106, illus.

A summary of research undertaken at Bell Telephone Laboratories to reduce the limitations on the reproducibility, reliability, and performance of germanium triodes; comparison of the performance characteristics of point-contact and junction units developed from 1949 to 1951; applications.

ELECTRONIC TUBES

Thermionic Emitters Under Pulsed Operation. R. Loosjes, H. J. Vink, and C. G. J. Jansen. *Philips Technical Review*, Vol. 13, No. 12, June, 1952, pp. 337–345, illus. 9 references.

Equipment and method of an investigation of thermionic emitters under pulsed operation, in which the gradient of the potential in the oxide coating was found to differ considerably from that in a normal resistor, and the distribution of the velocities of the electrons emitted by an oxide-coated cathode differed from that expected by Maxwell's rule; characteristic electron velocity spectra; possible explanation and consequences of results; review of former investigations.

A Decade of Progress in Electron Tubes. H. J. Dailey. *Westinghouse Engineer*, Vol. 12, No. 4, July, 1952, pp. 136–140, illus. Improvements in cathodes, grid materials, vacuum envelopes, electron optics, and dissipation capabilities of anodes which have increased the reliability of electron tubes.

Letter to the Editor: Thermionic Emission and Electrical Conductivity of Oxide-Coated Cathodes. Shin-Ichiro Narita. *Journal of Applied Physics*, Vol. 23, No. 5, May, 1952, p. 599, illus. 3 references.

EXTRATERRESTRIAL PHENOMENA

The Dielectric Constant of Dry Air. J. V. Hughes and H. L. Armstrong. *Journal of Applied Physics*, Vol. 23, No. 5, May, 1952, pp. 501–504, illus. 9 references.

Development of a method for determining the real part of the dielectric constant of gases at microwave frequencies; determination of the dielectric constant of dry air at N.T.P. as 1.000569, at a frequency of 3,000 mc. per sec.; comparison with other results.

The Position and Movement on the Solar Disk of Sources of Radiation at a Frequency of 97 Mc/s. III. Ruby Payne-Scott and A. G. Little. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 32–46, illus. 8 references.

Radio-Frequency Radiation from the Constellation of Cygnus. J. H. Piddington and H. C. Minnett. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 17–31, illus. 18 references.

MEASUREMENTS & TESTING

A Differential-Voltmeter Using a Temperature-Limited Diode. V. H. Attree. *Journal of Scientific Instruments*, Vol. 29, No. 7, July, 1952, pp. 226–229, illus. 22 references.

Design and operation of a differential voltmeter for measuring true r.m.s. voltage in which the effect of changes in ambient temperature is negligible. The circuit uses a temperature-limited diode as a voltage-sensing element, has a long-term stability that is to ± 0.2 per cent of the nominal voltage, and detects short-term variations of 0.1 per cent.

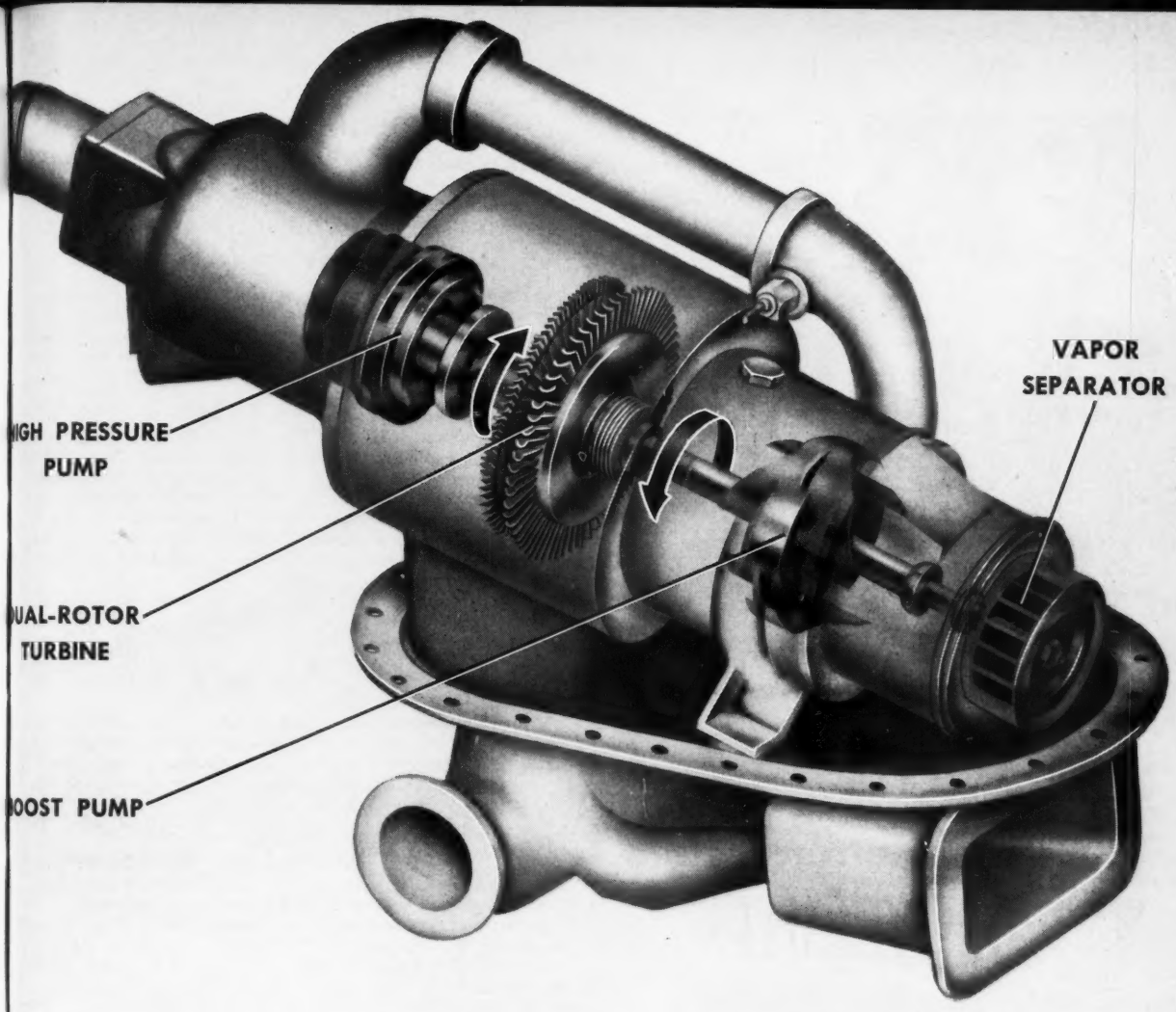
NAVIGATION AIDS

Distance Measuring Equipment. F. Penin and G. Lehmann. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 335–337, illus. 1 reference. Principles of operation; application to medium-distance air navigation.

NOISE & INTERFERENCE

Signal-To-Noise Characteristics of Detectors. Allen H. Schooley and Samuel F. George. *Tele-Tech*, Vol. 11, No. 7, July, 1952, pp. 60–63, 75, illus. 6 references.

Equipment, procedure, and results of an investigation of the effects on the signal-to-noise ratio of various characteristics of detectors of continuous wave signals embedded in noise. Four characteristic shapes of detectors were studied: linear, parabolic, semicubical, and clipped linear. A Sunstein photoformer was used as the detecting element.



THIS PUMP HAS PASSED THE OFFICIAL USAF QUALIFICATION TESTS

New G-E Afterburner Fuel Pump Saves Pounds, Eliminates System Complexity

3-in-1 Pump Is Light, Compact, Permits Climb Rates of Thousands of Feet Per Minute

To give you maximum efficiency in the smallest possible space, the boost pump, high pressure pump, and vapor separator are all combined in G.E.'s new reheat (afterburner) fuel pump. Because it is mounted in the fuel tank, the pump replaces boost pumps and their associated piping. This not only saves weight, but eliminates system complexity.

A built-in vapor separator permits climb rates of thousands of feet per minute. The pump is capable of delivering 86 gallons of vapor-free fuel every minute at a pressure of 550 psi.

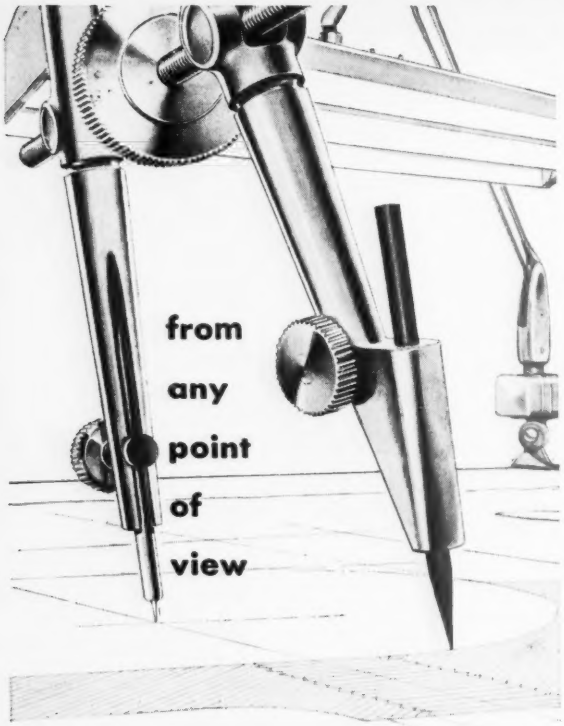
Although operated on bleed-air, the turbo-pump can be turned off while the engine is operating. This eliminates recirculation and its accompanying energy loss.

This pump can also be adapted for pumping various types of liquids to meet other pumping requirements. For information on G-E turbo-pumps contact your nearest General Electric Aviation Specialist or fill out the coupon and send to Section 210–65, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

General Electric Company
Section C 210–65
Schenectady 5, N. Y.
Please send me your bulletin GEA-5871, Aircraft Turbine-driven Fuel Pumps
For:
Reference Purposes
Immediate Project
Name .....
(Please print)
Position .....
Company .....
City ..... Zone ..... State .....

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY



you'll get better results with ARKWRIGHT

First, the drawing and second, the reproduction will be cleaner, clearer, sharper when you use Arkwright Tracing Cloths.

In the drawing you'll work more smoothly, easily—without pinholes, uneven yarns or other imperfections to slow you. You'll get clean, "feather-free" lines even over an erasure.

In the reproduction you'll always have clear, "contrasty" results because Arkwright Cloth is *permanently* transparent—won't discolor or turn brittle and opaque with age like inferior products.

Are *you* interested in results like these? Specify Arkwright Tracing Cloths. Write for samples to Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

ARKWRIGHT
Tracing Cloths
America's Standard for Over 30 Years

Flight Safety & Rescue (15)

The Human Factor in Aircraft Accidents. J. A. Newton. *ICAO Monthly Bulletin*, Vol. 7, No. 8, September, 1952, pp. 8–12, 1 reference.

Fuels & Lubricants (12)

Symposium on Gasification of Solid Fuels. I. (American Chemical Society, Divisions of Gas and Fuel Chemistry and Physical and Inorganic Chemistry, Diamond Jubilee Meeting, New York, N.Y., September 3–7, 1951.) *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 1028–1082, illus. 156 references.

Symposium on Gasification of Fuels. II. (American Chemical Society, Divisions of Gas and Fuel Chemistry and Physical and Inorganic Chemistry, Diamond Jubilee Meeting, New York, N.Y., September 3–7, 1951.) *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1547–1575, illus. 63 references.

Autoignition Properties of Certain Diesel Fuels. J. Enoch Johnson, John W. Crellin, and Homer W. Carhart, *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1612–1618, illus. 18 references.

Mononitration of *o*-Xylene. Kenneth A. Kobe and Philip W. Pritchett. *Industrial and Engineering Chemistry*, Vol. 44, No. 6, June, 1952, pp. 1398–1401, illus. 19 references.

The Filtration of Fine Particles. R. W. Cranston. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 154–159, illus. 2 references.

Theory and development of routine tests on the action of fine particle filters that remove particles larger than 20 microns from aircraft fuels; results of experimental evaluation of such filters.

Oxidation Characteristics of Some Diester Fluids. C. M. Murphy and Harold Ravner. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1607–1612, illus. 20 references.

Liquid Phase Hydrocarbon Oxidation. E. R. Booser and M. R. Fenske. *Industrial and Engineering Chemistry*, Vol. 44, No. 8, August, 1952, pp. 1850–1856, illus. 18 references.

Oxidation Characteristics of Lubricating Oils at High Temperatures. H. Diamond, H. C. Kennedy, and R. G. Larsen. *Industrial and Engineering Chemistry*, Vol. 44, No. 8, August, 1952, pp. 1834–1843, illus. 11 references.

Instruments (9)

Instrumentation. Ralph H. Munch. *Industrial and Engineering Chemistry*, Vol. 44, No. 3, March, 1952, pp. 81A, 82A, 84A, illus. Millivoltmeters and automatic potentiometers are studied in terms of their advantages and limitations for particular applications.

Device Cuts Out Faulty Autopilot. Philip Klass. *Aviation Week*, Vol. 57, No. 9, September 1, 1952, p. 42, illus. Construction and operation of a device that detects dangerous hard-over control signals caused by malfunctions in Lear, Inc.'s F-5 autopilot and disconnects it.

Lear Out to Crack Airline Autopilot Market. Joseph S. Murphy. *American Aviation*, Vol. 16, No. 8, September 15, 1952, pp. 38, 40, 44, illus.

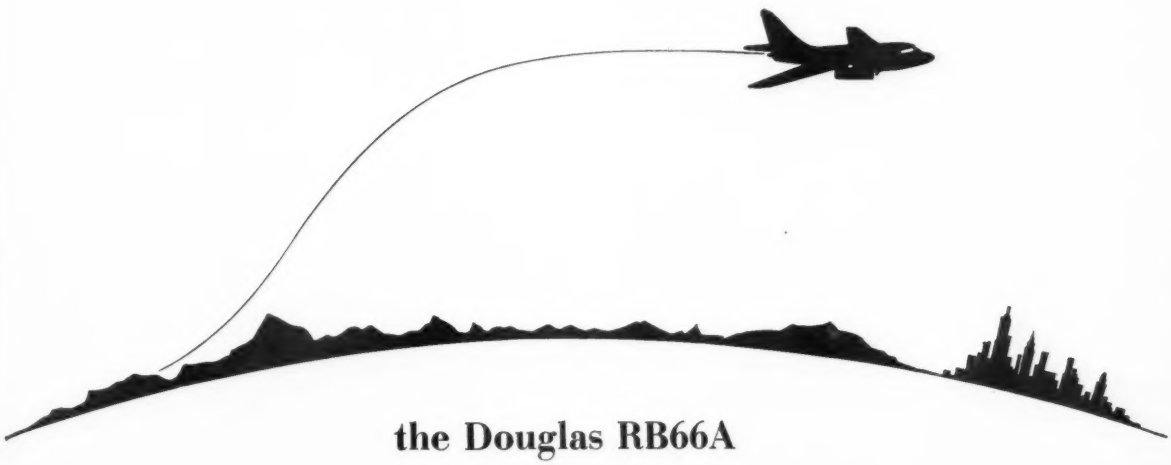
Construction, operation, production methods, and advantages of the Lear Model L-5, the commercial version of the military F-5 automatic pilot and approach coupler developed by Lear, Inc., in which an automatic cut-off protects the system from violent reaction to erroneous signals; service test installations.

Applications of the Muirhead-Pametrada Wave Analyser Type D-489. I. B. D. Banks. *Muirhead Technique*, Vol. 6, No. 2, April, 1952, pp. 11–14, illus. 1 reference.

Procedure and results of ground and flight tests of the Type D-489 Wave Analyser that has a frequency range of 19 cycles per sec. to 21 kc. per sec. and attains a high percentage frequency accuracy constant at all frequencies and a constant percentage bandwidth. The output of the analyzer corresponds in frequency and amplitude to the particular component selected and can be connected to an oscillograph.

Avionics Damper Steadies F-89. Philip Klass. *Aviation Week*, Vol. 57, No. 10, September 8, 1952, pp. 40, 42, 45, 46, 50, illus. Construction and operation of the 30-lb. sideslip stability augmenter developed by Northrop Aircraft, Inc., for its F-89s which eliminates sideslip and Dutch roll.

U.S. Air Force's new twin jet reconnaissance aircraft



the Douglas RB66A

Built to perform in the stratosphere, or to scrape treetops in low-level missions, the new U.S. Air Force RB66A will be one of the most versatile photo-reconnaissance planes ever designed.

Complete performance data must still remain secret, but the Air Force permits release of the information that the Douglas RB66A will be in the 600 to 700 mph class—with range enough to fly deep into enemy territory, and return. Powered by twin jets, slung in pods below the wing outboard of the fuselage, RB66A will carry the most modern photographic equipment, for accurate reports on operations.

Design of RB66A is another example of Douglas leadership in aviation. Planes that can be produced in quantity to fly *further and faster with a bigger payload* is a basic concept at Douglas.

Depend on *DOUGLAS* First in Aviation

working on Aircraft Contracts?

With more and more companies working on aircraft parts and assemblies, this booklet is extremely valuable and timely. Listing major 3M adhesive, coating and sealer applications, this booklet is based on 15 years' experience in the aircraft industry . . . and shows how 3M products, experience and engineering can help you.

FIFTIETH ANNIVERSARY 3M COMPANY 1902 ★ 1952

Be sure to send for your copy. Write 3M, Dept. 1212, 411 Piquette Avenue, Detroit 2, Michigan . . . . . ADHESIVES • COATINGS • SEALERS

MINNESOTA MINING AND MANUFACTURING COMPANY • ADHESIVES AND COATINGS DIVISION
411 PIQUETTE AVE., DETROIT 2, MICH.

GENERAL SALES OFFICE: ST. PAUL 6, MINN. • EXPORT OFFICE: 270 PARK AVE., NEW YORK 17, N. Y. • IN CANADA: LONDON, CANADA

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

Navy Buys Angle-of-Attack Unit. *Aviation Week*, Vol. 57, No. 7, August 18, 1952, pp. 49–52, illus.

Construction and performance of the Airstream Detection System produced by Specialties, Inc., and purchased for several new Navy fighters. The system, which consists of an airstream direction detector, a relay unit, and an indicator unit, provides the most economical angle of attack and warns against stalls.

Instrumentation. Ralph H. Munch. *Industrial and Engineering Chemistry*, Vol. 44, No. 1, January, 1952, pp. 83A, 84A, 86A, illus. The magnetic induction flowmeter is studied.

Thermocouple Thermal Error. Jack W. Rizika and Warren M. Rohsenow. *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 1168–1171, illus. 5 references.

Lighter-Than-Air (40)

France's Zodiac Airship. Arthur Frederick Ventry. *The Aeroplane*, Vol. 83, No. 2143, August 15, 1952, pp. 210, 211, illus. Comparison of the construction and operation of the 1909 and 1952 models of the Zodiac.

Machine Elements (14)

FASTENINGS

Pre-Tensioning for Preventing Fatigue Failure in Bolts. W. A. P. Fisher, R. H. Cross, and G. M. Norris. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 160–163, illus. 2 references.

Development, at the R.A.E., of a simple elastic theory of the reduction of bolt load fluctuation obtained by pre-tensioning; results of fatigue tests of the theory on $^3/_4$-in. B.S.F. bolts with various amounts of pre-tension.

Maintenance (25)

Aircraft Docking Facilities. *The Engineer*, Vol. 194, No. 5037, August 8, 1952, p. 201, illus.

Economic factors in ground maintenance and servicing; the Tiltman Langley Laboratories Ltd. plan for a permanent dock for modern nose-wheeled aircraft, in which the "Keylock" system of structural assembly is incorporated.

Pre-Fab Aircraft Docks. *Flight*, Vol. 62, No. 2273, August 15, 1952, p. 189, illus. Method of prefabricating aircraft maintenance docks that can be used as mobile stands or as fixed structures; applications to the Pionair DC-3 and the Ambassador.

Materials (8)

CORROSION & PROTECTIVE COATINGS

Corrosion. V, VI, Summary. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, Nos. 1, 2, 4; January, February, April, 1952; pp. 91A, 92A, 94A; 85A, 86A, 88A; 89A, 90A, 92A, illus.

Data summarized in chart form for corrosion of chemical lead, steel, Durimet 20, high Ni-Mo alloy, high Ni-Mo-Cr alloy, and Duriron by sulfuric acid at temperatures up to boiling and concentrations from 0 to 100 per cent.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 103A, 104A, 106A, illus. A discussion of several methods used in the literature for presenting or summarizing corrosion data.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 6, June, 1952, pp. 81A, 82A, 84A, illus.

Methods of preventing stress-cracking of welded-steel or cold-worked metals used for handling sodium hydroxide; analysis of the corrosion resistance of metals used for this purpose under varying conditions of temperature and concentration.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 71A, 72A, 74A, illus. Corrosion resistance of tantalum, niobium (columbium), zirconium, tungsten, and molybdenum metals is studied.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 8, August, 1952, pp. 87A, 88A, 90A, illus. Analysis of the conditions under which knife-line attack occurs in various types of welded austenitic stainless steels.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 9, September, 1952, pp. 101A, 102A, 104A, illus. Methods and techniques for determining the erosion-corrosion resistance of metals and alloys.

Corrosion Resistance of Titanium, Zirconium, and Stainless Steel. Lex B. Golden, I. Roy Lane, Jr., and Walter L. Acherman. *Industrial and Engineering Chemistry*, Vol. 44, No. 8, August, 1952, pp. 1930–1939, illus. 22 references.

Alternate Immersion Corrosion Test Equipment; Improvements in Design. Chuk-Ching Ma. *Industrial and Engineering Chemistry*, Vol. 44, No. 3, March, 1952, pp. 583–585, illus. 2 references.

Diffusion of Sodium Chloride Through Various Paint Systems. W. W. Kittelberger and A. C. Elm. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 326–329, illus. 5 references.

METALS & ALLOYS

Atmospheric Pollution. Louis C. McCabe. *Industrial and Engineering Chemistry*, Vol. 44, No. 3, March, 1952, pp. 113A, 114A, 116A, illus. 12 references. A review of the literature indicates that significant quantities of germanium, important in electronics, may be obtained from coal or ash.

Crystal Size Distribution of Electrolytic Metal Powders; Powders from Fused Electrolyte Baths. Chuk-Ching Ma. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 342–346, illus. 7 references.

High Chromium Stainless As a Substitute for 18-8. I—Heat Treating, Forging, Pressworking. Lester F. Spencer. *Steel Processing*, Vol. 38, No. 6, June, 1952, pp. 288–294, 298, illus.

Results of production and development work on the chemical, physical, and mechanical properties of high-chromium ferritic type 430 stainless steel and on the techniques of heat-treating, forging, and pressworking this metal for use as a substitute for high-priority type 302 (18-8) austenitic chromium-nickel stainless steel.

Eddy-Currents in Solid Cylindrical Cores Having Non-Uniform Permeability. Harold Aspden. *Journal of Applied Physics*, Vol. 23, No. 5, May, 1952, pp. 523–528, illus. 2 references.

Development of a method of estimating magnetization losses due to eddy-currents in solid cylindrical cores of ferromagnetic material which assumes that the core has complex permeability in order to show the effects of hysteresis upon the degree of flux penetration.

Hard Facing for Impact. Howard S. Avery. *Welding Journal*, Vol. 31, No. 2, February, 1952, pp. 116–143, Discussion, pp. 143–145. 16 references.

Analysis of factors in the choice of hard-facing alloys for impact resistance; properties of martensitic irons, martensitic steels, and austenitic steels; equipment, testing methods, design considerations, and applications for light, medium, and heavy impact.

Instrumentation. Ralph H. Munch. *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 97A, 98A, 100A, illus. Magnetic permeability is used to indicate the physical structure of some alloy steels.

X-Ray Diffraction by Face-Centered Cubic Crystals with Deformation Faults. M. S. Paterson. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 805–811, illus. 13 references.

Results of calculations of X-ray diffraction effects for face-centered cubic crystals with deformation faults. Derivation of expressions for the reciprocal lattice intensity distribution; method of determining the intensity of faulting from this distribution; summary of diffraction effects in a growth faulted crystal.

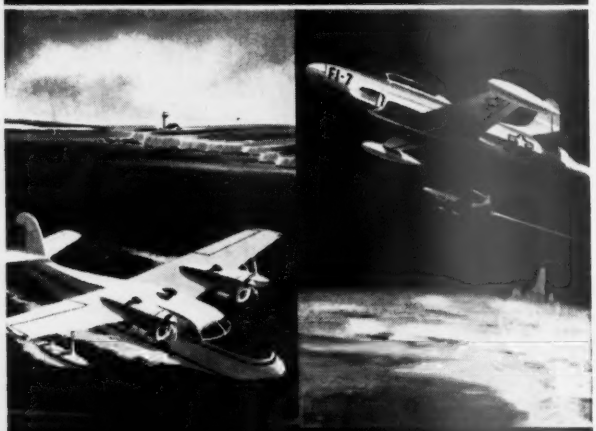
Measurement of the Internal Energy in Copper Introduced by Cold Work. Benjamin Welber. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 876–881, illus. 17 references.

Atmospheric Pollution. Louis C. McCabe. *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 121A, 122A. 4 references. Tests on electrostatic precipitators, operated wet, for the recovery of fumes and gases from aluminum alloy processing; foundry practice; recovery equipment.

Magnesium: Neglected Plane Material. H. Spencer Peterson. *Aviation Week*, Vol. 57, No. 9, September 1, 1952, pp. 21–23, 25–27, illus. Advantages of using magnesium in primary structures; results of production experience with and tests of magnesium wings.

Photometric Determination of Zirconium in Magnesium Alloys. Glenn B. Wengert. *Analytical Chemistry*, Vol. 24, No. 9, September, 1952, pp. 1449–1451, illus. 9 references.

From Water Level To Stratosphere...



Pittsburgh
FABSEAL
Makes Flying Safer...
More Efficient!

Millions of flying hours prove the dependable performance of these impregnated fabric tapes in civilian and military use!

● Many of America's leading builders of aircraft use Pittsburgh's FABSEAL Tapes with complete confidence in their outstanding quality to seal flying boats, pressurized cabins and for other applications where there is considerable racking movement.

● FABSEAL Tapes are impregnated fabric of uniform density, resistant to water, gasoline and oil. They are available in .015″ thickness and in widths from ½″ to 12″, packages in rolls of 50 feet.

● These tapes are particularly designed for use in fluid or air containers where excessive pressures are experienced. They are also adapted for sealing structural members where flexibility and vibration present unusual requirements. FABSEAL Tapes can also be bolted, riveted or screwed between metal, wood or fiber members to provide a fillet that assures a complete seal.

● Call on us for advisory service. Our wide experience in the aircraft field often can save you time and money.

PITTSBURGH PLATE GLASS CO., Industrial Paint Div., Pittsburgh, Pa. Factories: Milwaukee, Wis.; Newark, N. J.; Springdale, Pa.; Houston, Texas, Los Angeles, Calif.; Portland, Ore. Ditzler Color Div., Detroit, Michigan. The Thresher Paint & Varnish Co., Dayton, Ohio. Forbes Finishes Division, Cleveland, Ohio. M. B. Suydam Div., Pittsburgh, Pa.

PITTSBURGH PAINTS
PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS
PITTSBURGH PLATE GLASS COMPANY

The Rise of Titanium. *Westinghouse Engineer*, Vol. 12, No. 4 July, 1952, pp. 114–117, illus. Characteristics of titanium; sources of ore supplies; nonmetallic forms; companies producing and processing titanium; method of producing titanium metal.

Titanium at Work in Jet Engines. P. G. DeHuff and W. S. Hazelton. *Westinghouse Engineer*, Vol. 12, No. 4, July, 1952, pp. 118–120, illus. Problems in the use of titanium and titanium alloys; techniques of forging, joining, and machining titanium for jet engines.

NONMETALLIC MATERIALS

Butadiene-Methacrylic Acid Copolymers as Rubber-to-Steel Adhesives. Charles E. Frank, Gerard Kraus, and Albert J. Haefner. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1600–1603, illus. 17 references.

Flow of Plastics Materials in Pipes. Bengt O. A. Hedström. *Industrial and Engineering Chemistry*, Vol. 44, No. 3, March, 1952, pp. 651–656, illus. 8 references.

Symposium on Elastomers. (American Chemical Society, Division of Rubber Chemistry, Diamond Jubilee Meeting, New York, N. Y., September 3–7, 1951.) *Industrial and Engineering Chemistry*, Vol. 44, No. 4, April, 1952, pp. 695–861, illus. 761 references.

Longitudinal and Transverse Ultrasonic Waves in a Synthetic Rubber. A. W. Nolle and P. W. Sieck. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 888–894, illus. 7 references.

Measurement of velocity and attenuation of longitudinal and transverse ultrasonic waves in a buna-N vulcanizate at 2, 5, and 10 mc., over a range of temperatures; computation of values of the bulk modulus and of the complex shear modulus; apparatus, method, and results.

Electron Microscopy of Synthetic Latices. Samuel H. Maron, Carl Moore, and Allen S. Powell. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 900–905, illus. 9 references.

Equipment, techniques, and results of a study made by electron microscopy in which the particle size and size distribution were determined for 22 synthetic latices of various types, including GR-S latices Types II, III, and V and polystyrene latices.

Electrical Analog Method for Studying Elastomer Behavior. R. B. Stambaugh. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1590–1594, illus. 8 references.

Lignin-Reinforced Nitrile, Neoprene, and Natural Rubbers. J. J. Keilen, W. K. Dougherty, and W. R. Cook. *Industrial and Engineering Chemistry*, Vol. 44, No. 1, January, 1952, pp. 163–167, illus. 6 references.

Low Temperature Behavior of Silicone and Organic Rubbers. K. E. Polmanteer, P. C. Servais, and G. M. Konkle. *Industrial and Engineering Chemistry*, Vol. 44, No. 7, July, 1952, pp. 1576–1581, illus. 10 references.

Modulus and Relaxation of Elastomers in Torsion at Low Temperatures. Melvin Mooney and W. E. Wolstenholme. *Industrial and Engineering Chemistry*, Vol. 44, No. 2, February, 1952, pp. 335–342, illus. 11 references.

Meteorology (30)

The Growth of Cloud Drops by Condensation. I—General Characteristics. P. Squires. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 59–86, illus. 21 references.

The Influence of Meteorological Conditions on Rain-Making in the Sydney Area. E. J. Smith. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 87–103, illus. 7 references. Analysis of results of rainmaking experiments in the Sydney Area between January, 1948, and June, 1950, in which 88 flights were made and dry ice was used to seed the clouds.

The Relation Between Air-Pressure Micro-Oscillations and Concurrent Synoptic Patterns. Walter H. Roschke, Jr. *Journal of Meteorology*, Vol. 9, No. 3, June, 1952, pp. 213–219, illus. 13 references.

Results of an investigation to determine the mechanism responsible for air-pressure micro-oscillations of periods less than one minute (as recorded by the Macelwane electromagnetic microbarographs at Floissant, Mo., and at Ottawa, Canada), in which correlations between these oscillations and the concurrent synoptic pattern were calculated.

1952

AERONAUTICAL

ENGINEERING

CATALOG

NOW

AVAILABLE!

CONTENTS:

- Complete technical data on hundreds of aircraft parts, materials, accessories and equipment.
- Over 40,000 individual listings to the manufacturers of more than 2,500 aircraft and guided missile parts.
- The names and latest addresses of the principal manufacturers of every type of aircraft and guided missile component now being produced.

ORDER NOW!

LIMITED SUPPLY

I.A.S. MEMBERS—1 Copy: Free of Charge (Additional Copies—$7.50 per copy)

NON-MEMBERS—$7.50 per Copy

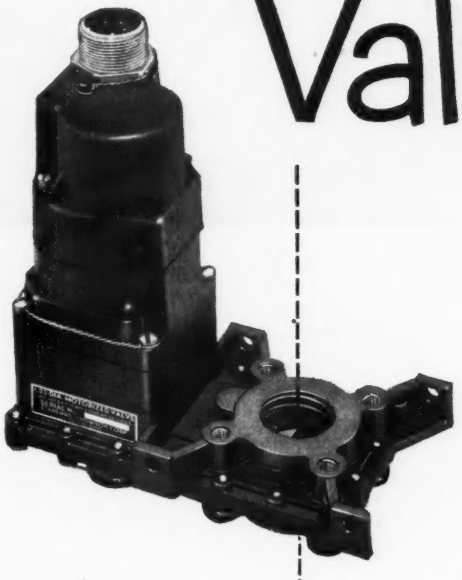
(Send Check or Money Order)

INSTITUTE OF THE AERONAUTICAL SCIENCES

2 East 64th St., New York 21, N.Y.

Standard-Thomson

Shut-off Valves



- **Wear-saving, retracting seals**
- **Override for positive positioning of gate**
- **Simple, one-direction actuator**

For fuel and hydraulic systems, Standard-Thomson Shut-Off Valves give three major advantages:

1. Standard-Thomson combines the proved sealing power of soft, synthetic rubber with a unique wear-saving device. During the entire valve cycle, the seals are *mechanically retracted*. The moving gate does not wear or bear on the seals.

2. For positive positioning of the gate, the unit embodies a *mechanical override* which disengages the actuator in full-open or full-closed position.

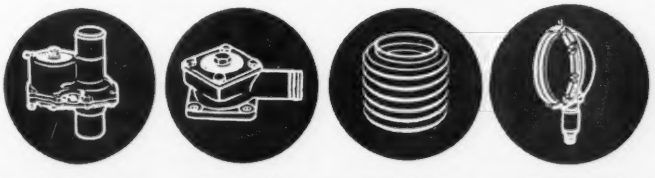
3. Use of a *uni-directional*, planetary gear actuator makes possible important savings in the design and cost of switching mechanism and motor.

Standard-Thomson Shut-Off Valves are furnished in diameters of 1″ to 3″, including a manually operated 2″ unit. The basic design can be adapted to shut-off service for any medium. For details, write:

STANDARD-THOMSON CORPORATION • DAYTON 2, OHIO

Standard-Thomson

Makers of USAF-approved bellows • valves • lights



Crankcase Pressurizing Valve | Barometric Pressure Valves | Tech-Forge Flexible Couplings | Vaporproof Cabin Lamp

SKY MASTERY DEPENDS ON quality gears

ON THE PRATT & WHITNEY TURBO WASP
GEARS ARE MANUFACTURED BY
FOOTE BROS.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

The Flow of a Liquid Past a Barrier in a Rotating Spherical Shell. Robert R. Long. *Journal of Meteorology*, Vol. 9, No. 3, June, 1952, pp. 187–199, illus. 17 references.

Apparatus and results of an investigation of the effect of large mountain barriers on zonal currents in the atmosphere, in which obstacles of various sizes and shapes were moved zonally in a rotating spherical shell of liquid; observational techniques and problems.

Recent Developments in Radio Location of Thunderstorm Centers. W. J. Kessler and S. P. Hersperger. *American Meteorological Society, Bulletin*, Vol. 33, No. 4, April, 1952, pp. 153–157, illus. 11 references.

Comparison of the triangulation method for the radio location of thunderstorms, used by the Army Air Forces during World War II, and of a proposed single-station location technique under investigation at the University of Florida which is based on the analysis of the waveforms of atmospherics.

Comparison of Three Multicylinder Icing Meters and Critique of Multicylinder Method. Wallace E. Howell. *U.S., N.A.C.A., Technical Note No. 2708*, June, 1952. 40 pp., illus. 17 references.

In-use comparison and analysis, at Mount Washington Observatory, of the relative effectiveness and accuracy of three multicylinder cloud meters fundamentally similar but differing in important design details; design-improvement recommendations; an evaluation of the multicylinder methods and the validity of its theoretical basis.

The High Latitude East-West Asymmetry of Cosmic Rays. D. W. P. Burbury and K. B. Fenton. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 47–58, illus. 18 references.

A Quantitative Method for 24-Hour Jet-Stream Prognosis. H. Riehl and C. O. Jenista. *Journal of Meteorology*, Vol. 9, No. 3, June, 1952, pp. 159–166, illus. 8 references.

Derivation of a formula for the rate of propagation of isotachs on a constant-pressure surface; outline of a computational routine developed during a period of experimental forecasts; method and results of verifying 24-hour forecasts.

Military Aviation (24)

Soviet Polar Potential: A New Look. William G. Key. *Pegasus*, Vol. 19, No. 3, September, 1952, pp. 1–8, illus.

A consideration of Soviet capability to launch sustained air operations against the North American continent, made possible because of the new intercontinental turboprop bomber (TuG-75) with speeds between 550 and 650 m.p.h. and a refined version of the long-range German V-2 weapon.

Short-Life Aircraft. Partial Contents: The West Turns Out Its Pockets—Can Air Defense Be Bought More Cheaply? Pierre M. Gallois. Germany's "De-Refinement Programme." A. Eschenauer. Just Why Are Aircraft So Costly? *Interavia*, Vol. 7, No. 7, July, 1952, pp. 363–382, illus. 1 reference.

NATO Air Build-Up. Partial Contents: NATO Air Power in Europe. Air Power, an Instrument for European Unity. P. M. Gallois. British Commonwealth and NATO. Norman Macmillan. NATO's Air Force and Italy. Carlo Unia. Germany in the Western European Defence System. *Interavia*, Vol. 7, No. 8, August, 1952, pp. 419–441, illus. 1 reference.

Missiles (1)

Bolts From the Blue! Canadian Progress on Guided Missile Research. J. J. Green. *Avro Canada Jet Age*, Vol. 1, No. 2, Summer, 1952, pp. 4–6, illus.

Parachutes

Drag Chute: Something for Nothing. *Aviation Week*, Vol. 57, No. 9, September 1, 1952, pp. 17, 18, illus. Results of service experience with drag parachutes for landing hot jet bombers; purchase and maintenance costs of the parachutes are compared with savings on jet bomber tires.

Photography (26)

An American Method of Photographing Flow Patterns. F. N. M. Brown. (Second Midwestern Conference on Fluid Mechanics, South Bend, Ind., March, 1952.) *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 164–169, illus.

Construction and operation of the nonreturn-type smoke tunnel for flow visualization at the University of Notre Dame which has a square working section 2 by 2 by 3 ft. long and is powered by a three-phase 15 hp. motor driving a four-bladed fan through a double cone transmission in a speed range between 15 and 90 ft. per sec.; photographic equipment and technique.

Power Plants

Engines at the Show. *The Aeroplane*, Vol. 83, No. 2147, September 12, 1952, pp. 402–404, illus. Construction and performance of power plants shown at the S.B.A.C. Farnborough exhibit.

JET & TURBINE (5)

Jet Propulsion—A Strain on Men and Nations. Pierre M. Gallois. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 304–307, illus. Design, economic and personnel changes, and problems in the development and increased use of jet-propelled aircraft.

How Much Does Jet Propulsion Cost? Eugen Sänger. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 338–340, illus. An analysis of the cost and efficiency of various types of jet engines and of jet-engine fuels and propellants.

Some Combustion Developments in Aeronautical Turbines. *The Engineer*, Vol. 194, No. 5043, September 19, 1952, p. 383, illus.

Combustion Chambers for Turbine Power Plants. Herbert Wehner. *Interavia*, Vol. 7, No. 7, July, 1952, pp. 395–400, illus. 5 references.

Types of combustion chambers for jet turbine power plants; development of requirements and solutions of a combustion chamber; values influencing combustion efficiency; requirements for fuel injection nozzles and fuels; ignition systems; structural materials.

Production of the "Nene" by Hispano-Suiza. Jacques Blanc. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 320–324, illus.

Turbine Jets of 1952. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 316–319, illus. 1 reference.

A list of turbojet engines, classified into seven type and thrust brackets, which gives maker and type, take-off thrust (dry), maximum continuous thrust, characteristics, dimensions, and dry-weight pounds.

New Ignition Better, Yet Cheaper. Philip Klass. *Aviation Week*, Vol. 57, No. 12, September 22, 1952, pp. 47, 48, 50, illus.

Development, construction, operation, and advantages of the Scintilla TLN-10 jet-engine ignition that weighs only 7 lbs. and starts under adverse conditions, including fouled or fuel-wetted plugs; comparison with model TEN.

RAM-JET & PULSE-JET

Better Way to "Gulp" Ramjet Air. *Aviation Week*, Vol. 57, No. 9, September 1, 1952, p. 39, illus. Advantages and disadvantages of a method of gulping oncoming ram-jet air which uses a continuous-compression type of inlet for Mach Numbers above 3.0.

RECIPROCATING (6)

The Filtration of Fine Particles. R. W. Cranston. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 154–159, illus. 2 references.

Theory and development of routine tests on the action of fine particle filters that remove particles larger than 20 microns from aircraft fuels; results of experimental evaluation of such filters.

ROCKET (4)

Aerodynamic Research with Rocket-Propelled Models. *The Engineer*, Vol. 194, No. 5039, August 22, 1952, pp. 254, 255, illus.

Investigations on flight performance in the transonic and supersonic speed ranges of rocket-propelled, free-flying research models, at the Pilotless Aircraft Research Station of the N.A.C.A. at Wallops Island, Va.

Jet Assisted Take-Off. Theodore von Kármán. *Interavia*, Vol. 7, No. 7, July, 1952, pp. 376–379, illus. Development, advantages and disadvantages, and applications of rockets for take-off assistance.

Production (36)

The S.B.A.C. Flying Display and Static Exhibition. I, II, III. *The Engineer*, Vol. 194, Nos. 5041, 5042, 5043, September 5, 12, 19, 1952, pp. 325, 326; 355, 356; 376–379, illus. The major products of the British aircraft manufacturers on display.

How the Air Force Aids Small Business. *Aviation Week*, Vol. 57, No. 7, August 18, 1952, pp. 21–25, 27, 28, illus.

Organization, methods, and statistics of the Air Force Small Business Program that plans to give small aircraft and aircraft component producers as large a share as possible of prime contracts and subcontracts. Map shows the location of small business prime contractors and the amount of money paid to them by the U.S.A.F. in 1951.

Subcontractors Build Half the P2V-5. *Aviation Week*, Vol. 57, No. 10, September 8, 1952, pp. 32, 35, illus. Lockheed Aircraft Corp.'s subcontracting program for its military aircraft.

Production of the "Nene" by Hispano-Suiza. Jacques Blanc. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 320–324, illus.

Equipment and raw materials, machining and forging techniques, and assembly and test methods used at Hispano-Suiza for the production of the Rolls-Royce Nene jet engine.

Turn of the Transport Tide. *The Aeroplane*, Vol. 83, No. 2147, September 12, 1952, pp. 394–397, illus. Production status of transport aircraft shown at the S.B.A.C. Farnborough exhibit.

Redux for Spars. *The Aeroplane*, Vol. 83, No. 2143, August 15, 1952, pp. 216–218, illus.

Results of research on the application of the Redux bonding process to composite spar-boom construction for the Fokkers S-11 Instructor trainer; comparison of the compression strength of Redux-bonded booms with that of riveted booms.

Belt Grinds Fast, Accurate Tapers. Irving Stone. *Aviation Week*, Vol. 57, No. 11, September 15, 1952, pp. 34, 38, 41, illus.

Development by the Carborundum Co. and Bell Aircraft Corp. of an accurate grinding belt that removes wide stock metal rapidly; techniques and results of experimental runs on a modified Hill Acme polishing machine in which the grinding belts were used for skin tapering in two directions; comparison with skin-milling method.

Equipment and Design. Charles Owen Brown. *Industrial and Engineering Chemistry*, Vol. 44, No. 5, May, 1952, pp. 91A, 92A, 94A, illus. Welds on light metals made possible by preliminary tests that determine best practice for a particular type seam.

Combinable Electronic Controls for Air-Operated Heavy-Duty Spot Welding Machines. E. Gut. *Brown Boveri Review*, Vol. 39, No. 4, April, 1952, pp. 135–140, illus. A synchronous precision electronic control that utilizes the unit construction principle with various modified forms for practically all kinds of spot welding.

Flash Welding of Components for Aircraft and Similar Applications. J. H. Cooper. *Welding Journal*, Vol. 31, No. 2, February, 1952, pp. 109–115, illus. Improvements and refinements in weld variable control, instrumentation, weld quality control, inspection and testing, and designing for welding.

Partners in Production; Thirty Thousand Canadians in Some 450 Sub-Contracting Companies Combine Efforts to Help Build CF-100 Airframe. Leander F. McCaul. *Avro Canada Jet Age*, Vol. 1, No. 2, Summer, 1952, pp. 1–3, illus.

New Stamping Process Developed at Douglas Aircraft. Thomas A. Dickinson. *Steel Processing*, Vol. 38, No. 6, June, 1952, pp. 277–279, illus. Construction and operation of the Wheelon hydraulic press; comparison of the Wheelon and Gruerin forming processes.

Reference Works (47)

Directory of Sources of Supply and Services. *Aircraft*, Vol. 14, No. 6, June, 1952, pp. 23, 25, 26, 28, 31, 32, 35, 36, 38, 41, 43–46, 48, 50, 51, 53, 54, 56, 59, 60, 62, 64, 67, 70, 73, 74, 76–80, 82, 83, 85–88, 90–92, 95–98, 100–102, 104, 106, 108, 111, 112, 114, 116, 118–120, 122, 125–127.

An alphabetically arranged directory of aircraft products and services which names companies producing supplies or rendering services. A separate alphabetical listing of company names is added.

Turbine Jets of 1952. *Interavia*, Vol. 7, No. 6, June, 1952, pp. 316–319, illus. 1 reference.

A list of turbojet engines, classified into seven type and thrust brackets, which gives maker and type, take-off thrust (dry), maximum continuous thrust, characteristics, dimensions, and dry-weight pounds.

Rotating Wing Aircraft (34)

Helicopters for the Army. R. H. Bower. *The Aeroplane*, Vol. 83, No. 2141, August 1, 1952, pp. 156, 157, illus.

Helicopter Progress on View (at Farnborough). *The Aeroplane*, Vol. 83, No. 2147, September 12, 1952, pp. 400, 401, illus.

Kaman K-225 Twin-Rotor Gas Turbine Helicopter. *Aviation Week*, Vol. 57, No. 7, August 18, 1952, pp. 35, 36, 38, 39, illus. 1 reference.

Sikorsky S-55 Single-Rotor Helicopter. *American Aviation*, Vol. 16, No. 8, September 15, 1952, pp. 22, 23, illus.

Sciences, General (33)

MATHEMATICS

On the Numerical Integration of Ordinary Differential Equations of the First Order. Per-Olov Löwdin. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 97–111, illus. 59 references.

An analysis of the connection between central-difference and backward-difference formulas for the numerical integration of ordinary differential equations which uses operator calculus and symbolic expansions; development of a new straightforward central difference method, applicable even to first-order systems with one-point boundary conditions, in which, for each step of integration, the largest unknown term is determined by an algebraic equation and the remaining difference correction is extremely small. The method is based on a formula closely associated with Simpson's rule.

A Second-Order Solution for an Oscillating Two-Dimensional Supersonic Airfoil. Alexander Wylly. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 685–696, 704, illus. 15 references.

Development of a second-order solution, by means of an iteration procedure, for an oscillating two-dimensional supersonic airfoil to include the higher-order terms in angle of attack and thickness in order that the relative importance of second-order terms and tendencies indicated by them may be evaluated. A linearized (or first-order) velocity potential, of suitable form for use in the iteration procedure, is developed as a power series approximation, in frequency, to the exact linearized solution.

A Method for Reducing the Analysis of Complex Redundant Structures to a Routine Procedure. L. B. Wehle, Jr., and Warner Lansing. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 677–684, illus. 8 references.

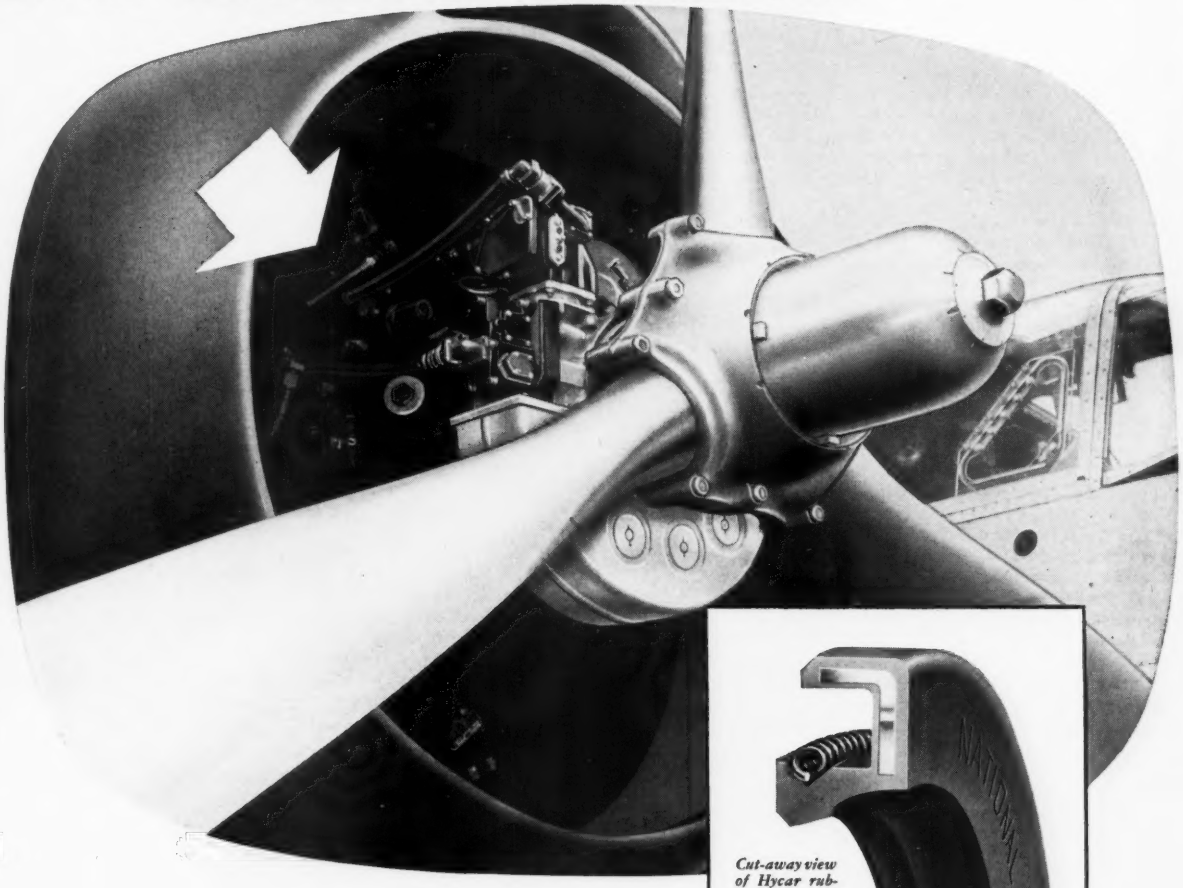
Matrix procedures are used to analyze statically indeterminate structures in a 3-phase method that covers the writing of the equilibrium equations that determine the load distribution after it has been made statically determinate, the tabulation of formulas and curves for flexibilities of certain structural elements, and the routine self-checking matrix operations.

A Mixing Theory for the Interaction Between Dissipative Flows and Nearly Isentropic Streams. Luigi Crocco and Lester Lees. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 649–676, illus. 22 references.

Analysis, by means of a simplified theoretical "model," of the concept of the transport of momentum from outer stream to dissipative flow (turbulent "mixing" or laminar diffusion) considered as the fundamental physical process determining the pressure rise that can be supported by the flow. Formula analyses cover basic equations of motion, expression for the mean temperature (the F-κ curve), mixing-rate and friction coefficient, reduction of equations of motion to a single equation for constant mixing coefficient, and the critical point of the equation for dF/dw_e and its significance.

Another new development using

B. F. Goodrich Chemical *raw materials*



Cut-away view of Hycar rubber seal. Seal has 6½" i.d., molded onto metal base, is spring-tensioned, precision-trimmed.

NO OIL LEAKS HERE
—because of HYCAR!

Oil seals designed and manufactured by National Motor Bearing Co., Inc., Redwood City, Calif., for Hamilton Standard Division, Windsor Locks, Conn. B.F.Goodrich Chemical Co. supplies the Hycar rubber only.

PREVENTING leakage from propeller oil control assemblies is a vital job—calls for a seal with unique advantages. The seal must be positive, must resist the deteriorating effects of oil, extreme temperatures and high surface speeds.

It was only natural that the seal manufacturer chose Hycar nitrile rubber—for Hycar meets these rigid requirements.

The Hycar rubber seals are precision-molded and compact in design because of critical space limitations. They operate in temperatures ranging from −65°F. to 220°F. And they withstand the severe abrasion conditions resulting from surface speeds of 3,250 f.p.m.

These Hycar rubber seals are suitable for use with AN-O-8 Grade 1100 and AN-O-9 Grade 1010 fluids, and MIL-O-5606 oil.

Perhaps one of the many Hycar rubber compounds can solve a problem for you—can help you improve or develop a sales-making product. For Hycar resists oil, gas, heat and cold, aging, abrasion and many chemicals. For helpful technical information, please write Dept. HH-12, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Hycar
Reg. U.S. Pat. Off.
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

On Heat Transfer over a Sweat-Cooled Surface in Laminar Compressible Flow with a Pressure Gradient. Morris Morduchow. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 705–712, illus. 10 references.

Derivation of an expression for the normal injection velocity distribution theoretically required to maintain a given uniform temperature along a porous surface in the laminar boundary-layer region of a compressible flow with a given velocity distribution outside of the boundary layer. Dorodnitsyn-type transformation is used to take into account the variation of fluid properties. The analytic method consists of applying the Kármán-Pohlhausen technique to both the energy and momentum boundary-layer equations for compressible flow and of using an additional heat-balance equation involving the coolant temperature; a closed-form approximate solution of the equations is derived; numerical examples.

The Dirac Delta-Function and the Summation of Fourier Series. M. R. Spiegel. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 906–909. 2 references.

Development of a method of summation of Fourier Series which uses ordinary linear differential equations with constant coefficients having inputs that depend on certain combinations of the Dirac delta-function.

A Mathematical Analysis of a Dielectric Amplifier. Louis A. Pipes. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 818–824, illus. 14 references.

A mathematical analysis of the fundamental circuit for dielectric amplifiers which assumes that the effective hysteresis curve of the amplifier's dielectric material may be represented by a hyperbolic sine function.

The Transfer Function of General Two Terminal-Pair RC Networks. Aaron Fialkow and Irving Gerst. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 113–127, illus. 7 references.

Partially Plastic Rotating Discs. Melvin Zaid. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 697–704, illus. 4 references.

Derivation, using the distortion energy theory, of an exact solution for the flat rotating disc in the plastic region. Infinitesimal strains are assumed, upon which exact solutions for stress and strain at any point in the disc are obtained for a general stress-strain law. In order to avoid discontinuities at the elastic-plastic boundary, elastic compressibility is taken into account. The earlier work of Nadai and Donnell is compared. Results are applied to both strain and non-strain hardening materials.

Electromagnetic Back-Scattering from Cylindrical Wires. C. T. Tai. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 909–916, illus. 8 references.

Development of a variational method of calculating the back-scattering cross section of cylindrical wires; application to the problem of broadside incidence; relation between this method and the induced e.m.f. method.

Longitudinal and Transverse Ultrasonic Waves in a Synthetic Rubber. A. W. Nolle and P. W. Sieck. *Journal of Applied Physics*, Vol. 23, No. 8, August, 1952, pp. 888–894, illus. 7 references.

Measurement of velocity and attenuation of longitudinal and transverse ultrasonic waves in a buna-N vulcanizate at 2, 5, and 10 mc., over a range of temperatures; computation of values of the bulk modulus and of the complex shear modulus; apparatus, method, and results.

Readers' Forum: Determination of Modes and Frequencies Above the Fundamental by Matrix Iteration. P. Cicala. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 719, 720. 2 references.

Structures (7)

A Method for Reducing the Analysis of Complex Redundant Structures to a Routine Procedure. L. B. Wehle, Jr., and Warner Lansing. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 677–684, illus. 8 references.

Matrix procedures are used to analyze statically indeterminate structures in a 3-phase method that covers the writing of the equilibrium equations that determine the load distribution after it has been made statically determinate, the tabulation of formulas and curves for flexibilities of certain structural elements, and the routine self-checking matrix operations.

G-ALRV
BRISTOL TYPE 173 world's first twin engine helicopter:
Powered by two Alvis Leonides LE 25 HMV engines driving twin rotors. The Type 173 carries 10 passengers or 2500 lbs. of freight.

BRISTOL CHOOSES WHARTON UNIVERSAL JIG & FIXTURE SYSTEM

FOR EXPERIMENTAL WORK ON THEIR NEW PROTOTYPE 173 HELICOPTER

Bristol and many other top Aircraft manufacturers of the world have discovered the tremendous speed and flexibility which the Wharton System lends to tooling-up. Now in a matter of a few short hours, the most difficult jig or fixture problem can be solved.

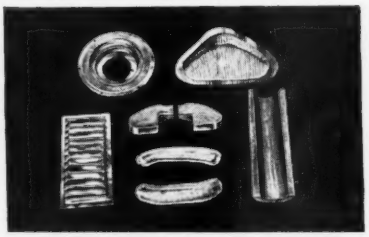
The Wharton Universal Jig & Fixture System is the world's only proven system. It makes present methods of building jigs & fixtures obsolete for Short Run Production, Experimental Work, Product Modification and Inspection. Now is the time to investigate the Wharton System. It will definitely change your tooling methods as it has for leaders of industry the world over.

WRITE FOR ILLUSTRATED PAMPHLETS

WHARTON & WILCOCKS of America Inc. 17 Battery Place, New York

Rockets blast in a flash of fire from the U. S. Air Force's Northrop Scorpion F-89D during armament tests over the Southern California desert.

Thermoflex Thermal Insulation Blanket being applied to a jet engine exhaust cone. Special grooving assures precision fit around cylindrical and conical surfaces . . . allows for expansion at high temperature.



Typical preformed shapes of Thermoflex, custom-made to insulate the intricate and often irregular surfaces involved in many aircraft applications. *Reg. U.S. Pat. Off.

J-M Thermoflex Insulation *controls searing heat of twin jets*

The new F-89D Scorpion . . . rocket-blasting, twin-jet, all-weather interceptor manufactured for the Air Force by Northrop Aircraft, Inc. . . . is equipped with Thermoflex* High Temperature Thermal Insulation Blankets for aft-frame protection.

Thermoflex insulates the shaft housing of the F-89D's jet engine against searing heat . . . helps keep oil and bearing temperatures down to a safe level.

Thermoflex Blankets, standard protection on many Air Force and Navy jets, are custom-made. The insulation filler is made from highly stable Thermoflex RF Felt. This newly developed refractory fiber felt insulation is sealed between sheets of corrosion-resistant metal foils.

During manufacture, careful attention is given to the accuracy of cutouts for engine supports, actuator mountings, fuel lines, thermocouple leads and other controls. Edges at cutouts are sealed to prevent fuel penetration into the felt insulation filler. This precision fabrication of Thermoflex Blankets assures maximum insulation for the entire application.

In addition to insulation blankets for tail pipes, engine cones, turbine casings and afterburners . . . Thermoflex is also made in special preformed shapes to insulate, protect and fireproof fluid storage tanks air-conditioning systems, thermal de-icing ducts and many other assemblies in all types of aircraft.

For the complete story of Thermoflex Insulation for aircraft power plants and airframes, send for illustrated folder IN-136A. Address Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PRODUCTS for the AVIATION INDUSTRY

Thin Multi-Walled Sections. William Morse. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 170–172, illus. Development of a method of finding the distribution of direct shear stress and the position of the flexural axis for a 2-cell and a 3-cell section.

Readers' Forum: Note on Creep Buckling of Columns. George Gerard. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, p. 714. 1 reference.

Torsion of a Circular Cylinder Having a Spherical Cavity. Chih-Bing Ling. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 149–156, illus. 6 references.

Development of a torsion solution, based on the Michell-Föppl theory, for an infinite circular cylinder with a symmetrically located spherical cavity; numerical values for the effect of the cavity on the maximum shear stress in the cylinder.

Plastic Collapse Loads for Plane Frames. I, II. B. G. Neal and P. S. Symonds. *The Engineer*, Vol. 194, Nos. 5041, 5042, September 5, 12, 1952, pp. 315–319; 363, 364, illus. 8 references.

A discussion of a theoretical basis of a technique for determining plastic collapse loads; application of plastic design methods, based on the calculation of the loads at which a structure collapses owing to excessive plastic deformation, to plane frames of ductile materials (such as mild steel).

Partially Plastic Rotating Discs. Melvin Zaid. *Journal of the Aeronautical Sciences*, Vol. 19, No. 10, October, 1952, pp. 697–704, illus. 4 references.

Derivation, using the distortion energy theory, of an exact solution for the flat rotating disc in the plastic region. Infinitesimal strains are assumed, upon which exact solutions for stress and strain at any point in the disc are obtained for a general stress-strain law. Elastic compressibility is considered in order to avoid discontinuities at the elastic-plastic boundary. The earlier work of Nadai and Donnell is compared. Results are applied to both strain and non-strain hardening materials.

A Problem of Finite Bending of Circular Ring Plates. Eric Reissner. *Quarterly of Applied Mathematics*, Vol. 10, No. 2, July, 1952, pp. 167–173. 3 references.

Analysis of the applicability of beam theory and plate theory as related to the problem of axisymmetrical transverse bending of a circular ring plate under the action of transverse edge forces.

Notes on the Power-Speed-Weight Relationship for Vehicles. K. S. M. Davidson. *Stevens Institute of Technology, Experimental Towing Tank, Technical Memorandum No. 97*, January, 1951. 65 pp., illus. 3 references.

Preliminary form of an analytic method that includes within a single frame of reference the relative power-speed-weight potentialities and limitations of widely varying types of vehicles, with emphasis on air-borne and water-borne transports; comparison with the Gabrielli-von Kármán limit line.

Thermodynamics (18)

Approximations in Transient Surface Heating. J. C. Jaeger. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 5, No. 1, March, 1952, pp. 1–9, illus. 7 references.

Development of exact solutions for the surface temperature of a semi-infinite solid that is heated over a region of its surface, where the shape of the region approximates a half-plane, a strip, a rectangle, a square, or a circle.

Cross-Flow Heat Exchangers. I. J. K. Reid. *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 173–176, illus. 7 references. A summary of the general theory applicable to coolers and heaters.

Water-Borne Aircraft (21)

Saunders-Roe Princess Turboprop Flying-Boat Aircraft, England. *The Aeroplane*, Vol. 83, No. 2146, September 5, 1952, pp. 353–361, illus.

Martin's New Research Model M-270 Has Something New in Flying Boat Hulls. *The Martin Star*, Vol. 11, No. 6, June, 1952, pp. 3–5, illus. Development; results of taxi and flight tests.

Wind Tunnels & Research Facilities

Aerodynamic Research with Rocket-Propelled Models. *The Engineer*, Vol. 194, No. 5039, August 22, 1952, pp. 254, 255, illus.

Investigations of flight performance in the transonic and supersonic speed ranges on rocket-propelled, free-flying research models at the Pilotless Aircraft Research Station of the N.A.C.A. at Wallops Island, Va.

Silencing a Jet Engine Test House. *Interavia*, Vol. 7, No September, 1952, pp. 504, 505, illus. 3 references. Analysis the sources of sound in jet engines; methods used in the silencing system employed in the Bristol Olympus test houses.

From Newton's Note Book to Mammoth Research Organizations; An Interview with Professor Theodore von Kármán. *Interavia*, Vol. 7, No. 8, August, 1952, pp. 431, 432, illus.

Disadvantages of organized research; proposed goals for international cooperation by the Advisory Group for Aeronautical Research and Development (A.G.A.R.D.), N.A.T.O.; map showing Europe's major research centers.

Fortieth Anniversary of the Deutsche Versuchsanstalt für Luftfahrt (German Aeronautical Research Institute). Friedrich Seewald. *Interavia*, Vol. 7, No. 8, August, 1952, pp. 433, 434, illus.

Preliminary Survey of Boundary-Layer Development at a Nominal Mach Number of 5.5. Harold L. Bloom. *U.S., N.A.C.A., Research Memorandum No. E52D03*, June 18, 1952. 26 pp., illus. 7 references.

Preliminary boundary-layer and skin-friction data on a flat-plate model obtained in a 6- by 6-in. hypersonic continuous-flow wind tunnel with a nominal test section Mach Number of 5.5.

G-E Dewpoint Recorder Monitors Moisture Content in NACA Wind Tunnel. *General Electric Special Products Digest*, Vol. 1(No. 5, September, 1952, p. 1, illus.

An American Method of Photographing Flow Patterns. F. N. M. Brown. (Second Midwestern Conference on Fluid Mechanics, South Bend, Ind., March, 1952.) *Aircraft Engineering*, Vol. 24, No. 280, June, 1952, pp. 164–169, illus.

Construction and operation of the nonreturn-type smoke tunnel for flow visualization at the University of Notre Dame which has a square working section 2 by 2 by 3 ft. long and is powered by a three-phase 15 hp. motor driving a four-bladed fan through a double cone transmission in a speed range between 15 and 90 ft. per sec.

Now Available

1951 Aeronautical Engineering Index

(See Special I.A.S. Publications, Page 100)

MUSICK MEMORIAL TROPHY

"...most effective in furthering the safety of aircraft..."

The Musick Memorial Trophy, known throughout the world of aviation, is for annual award "to the group, body or individual that has recently made the contribution, development or improvement which by its practical application has become most effective in furthering the safety of aircraft with special reference to transoceanic aviation, or directly so by increasing the efficiency of aircraft."

The Trophy was established in 1938 by citizens of Auckland, New Zealand, in memory of Capt. Edwin C. Musick and his six companions in the "Samoan Clipper" who were lost in the South Pacific on January 12, 1938 while making the first commercial flight from the United States to New Zealand.

For its contribution in furthering the safety of transoceanic aircraft, the Sperry Engine Analyzer has recently won the Musick Memorial Trophy for 1951. This award was made to *John E. Lindberg, Jr.* and *James W. Wheeler* who jointly developed the Analyzer. At the time of this development, Lindberg was a staff engineer in the Pacific-Alaska Division of Pan American World Airways and Wheeler was head of the engine instrument department of the Sperry Gyroscope Company.

Acclaimed for its contributions to flight safety, the Analyzer is in wide use on commercial and military planes throughout the world. It immediately detects, locates and identifies detailed ignition and mechanical troubles in aircraft power plants either during flight or on the ground.

Sperry Gyroscope Company
Division of The Sperry Corporation
Great Neck, New York

BARBER COLMAN

IN MOST OF THE *transport* AIRCRAFT YOU SEE...

CONVAIR 240

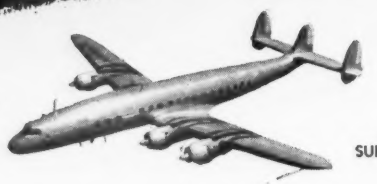
CANADAIR C-4

LOCKHEED CONSTELLATION

BOEING 377 STRATOCRUISER

DOUGLAS DC-6B

SAAB SCANDIA


LOCKHEED 1049 SUPER-CONSTELLATION

CONVAIR 340

SNCASE SE-2010 ARMAGNAC

DOUGLAS DC-3

Fifty-five world airlines are daily utilizing Barber-Colman automatic controls to maintain passenger comfort and flight safety conditions.

In fifteen years Barber-Colman Controls have been used on nearly 100 major models of transport, executive, and military aircraft representing over 20 airframe manufacturers. Applications include: complete temperature control systems for cabin, cockpit, flight station, lounge, cargo, camera, and electronic compartments; temperature control of hot air and electrically heated windshields; temperature control of carburetor air, manifold air, and oil; wing and empennage de-icing controls; overheat controls; trim tab positioning and synchronization controls; flap unbalance detection controls; low voltage warning controls; nose wheel steering controls; rudder boost override controls; plus miscellaneous actuator, air valve, Micropositioner*, and remote positioning applications.

AVRO JETLINER C-102

MARTIN 2-0-2A

MARTIN 4-0-4

DOUGLAS DC-6

CONVAIR TURBO-LINER

DOUGLAS DC-6A

IN MOST OF THE AIRCRAFT YOU SEE

BARBER-COLMAN COMPANY CONTROL SYSTEMS ARE USED!

BARBER COLMAN

*Reg. U.S. Pat. Off.

BARBER-COLMAN COMPANY

1245 ROCK STREET, ROCKFORD, ILLINOIS

Engineering Sales Offices: *Los Angeles, Seattle, Chicago, Baltimore, New York, Montreal*

Canadian Aircraft Representative: **ROUSSEAU CONTROLS, LTD.,** *Montreal Airport, Dorval, P. Que.*

Aeronautical Reviews — BOOKS

Book Notes

AIR TRANSPORTATION

World Airline Record, 1952 Edition. Chicago, Roy R. Roadcap & Associates, Publishers, 1952. 500 pp., maps. $12.50.

World Airline Record now covers every regularly scheduled air line, including Russia's. With the addition of 138 air lines now included for the first time, it presents comprehensive data on each of 240 carriers.

This edition, fourth in the annual series of operating, traffic, and financial analyses, also includes the following important new features: (1) exclusive service density maps (forty of these new maps graphically analyze point-to-point service volume over each segment, including all nonstop routings); (2) expanded operating and traffic analyses (a new compilation—density factors—gives a comparable picture of relative operating efficiency); (3) seasonal traffic charts; (4) completely rewritten and revised histories; (5) interim reports (these supplemental sections summarize up-to-the-minute plans and developments); (6) convenient indexing (all carriers are arranged according to continent and country).

Efforts have been made to present comparable data from all air lines. Exceptions were necessary in certain instances, however, since some data submitted could not be used because they were either incomplete or conflicting.

For convenience and uniformity of presentation, data for each air line are arranged under the following systematic headings: Route Map, History of Organization and Development, Management, Operating and Revenue Traffic Analysis, Seasonal Chart, Income Account, Income Account Analysis, Balance Sheet, Capitalization Ratios, and Historical Statistical. Income Account Analysis and Capitalization Ratio tables are included for most U.S. carriers.

ELECTRONICS

UHF Practices and Principles. Allan Lytel. New York, John F. Rider Publisher, Inc., 1952. 390 pp., illus., diagrs., figs. $6.60.

This book has been written for the student or technician who is familiar with the fundamental concepts and techniques used in standard broadcast receivers. A logical sequence is used to explain ultra-high-frequency concepts from their very beginning to their use in complete equipment.

The first three chapters provide an introductory background by discussing the nature of ultra high frequencies and how they differ from lower frequencies. Receiving antennas and transmission lines then are discussed. U.H.F. tuned circuits are investigated, and practical types are illustrated.

Next, ultra-high-frequency oscillators are described with the emphasis on practical circuits used in equipment. Then, U.H.F. commercial transmitting and receiving equipments are analyzed.

To keep up with the state of the art is always a problem in television and an exceptional problem in the case of U.H.F. Thus, a separate section has been devoted to developmental vacuum tubes that, as yet, are not in widespread use.

Because the type of test equipment and the nature of the circuits are unusual in the U.H.F. band, there is a special section devoted to this subject. Some of the techniques are so different from those normally used at lower frequencies that they need careful study. The appendix includes several charts and nomograms for simple calculation of important transmission line and antenna characteristics.

Radio Spectrum Conservation; A Program of Conservation Based on Present Uses and Future Needs. A Report of the Joint Technical Advisory Committee, IRE-RTMA. New York, McGraw-Hill Book Company, Inc., 1952. 221 pp., figs. $5.00.

Divided into six parts, this volume begins with a historical survey reviewing the development and increasing use of the radio spectrum. The other parts summarize the present state of knowledge of the various regions of the spectrum, present an ideal allocation table, offer specific suggestions to bring the actual allocation in line with the ideal, and give an extensive bibliography of the material in the field (146 references).

GLIDING & SOARING

Theory and Technique of Soaring. John Kukuski. London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corporation, 1952. 183 pp., diagrs., figs. $5.00.

This book has been written to provide a guide and a quick reference for soaring pilots. Explanations have been kept as simple as possible, and mathematical formulas have been used only where they could not be avoided. The author's facts are based on his personal experience in gliding and soaring both in England and on the Continent.

Contents: List of Symbols. I, Meteorology. II, Direct Sun Thermal Up-Currents. III, Instruments. IV, Mechanics of Soaring Flight. V, Loads Acting on Sailplane. VI, Launching Technique. VII, Landing Technique. VIII, Circling Technique. IX, Technique of Soaring. X, Sailplane Aerobatics. XI, Air Navigation. XII, The Parachute and Its Use. XIII, Instructing. Index.

For information on I.A.S. Library Service Facilities, see page 69

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

MATERIALS

A Symposium on High-Temperature Steels and Alloys for Gas Turbines, London, February 21–22, 1951. (Special Report No. 43.) London, The Iron and Steel Institute, July, 1952. 395 pp., illus., diagrs., figs. £3 3*s*.

Contents: I—Introduction. A Survey of the Development of Creep-Resisting Alloys, N. P. Allen.

II—User Aspects: Materials and Performance, A. T. Bowden and W. Hryniszak. Gas-Turbine Performance and Materials, J. B. Bucher. Influence of Operating Temperature on the Design and Performance of Gas Turbines, S. L. Bragg. Stresses in Gas-Turbine Discs and Rotors, R. W. Bailey.

III—Supplier Aspects: Nickel-Chromium-Titanium Alloys of the Nimonic 80 Type, L. B. Pfeil, N. P. Allen, and C. G. Conway. Some Proven Gas-Turbine Steels and Related Developments, D. A. Oliver and G. T. Harris. Effect of Warm-Working on an Austenitic Steel (G18B), G. T. Harris and W. H. Bailey. Development of a High-Temperature Alloy for Gas-Turbine Rotor Blades, G. T. Harris, and H. C. Child. Properties of Materials Intended for Gas Turbines, H. W. Kirkby and C. Sykes. Study of the Properties of a Chromium-Nickel-Niobium Austenitic Steel, H. W. Kirkby and C. Sykes. Creep-Resisting Ferritic Steels, E. W. Colbeck and J. R. Rait. Ferritic Steels for Gas Turbines, H. H. Burton, J. E. Russell, and D. V. Walker. Special Steels for Gas Turbines, W. E. Bardgett and G. R. Bolsover.

IV—Performance Aspects; Scaling and Fatigue at Elevated Temperatures. Scaling of Gas-Turbine Alloys, A. Preece. Scaling of Heat-Resisting Steels: Influence of Combustible Sulphur and Oil-Fuel Ash Constituents, C. Sykes and H. T. Shirley. Fatigue at High Temperatures, H. J. Tapsell. Fatigue Tests at Elevated Temperatures, P. H. Frith. Hot Fatigue Testing, H. E. Gresham and B. Hall. Variation of Elastic Moduli with Temperature for Various Steels and Pure Metals, G. T. Harris and M. T. Watkins.

V—Special Casting Techniques. Centrispun High-Alloy-Steel Aero-Engine Components: Part I—The Centrispinning Process, A. E. Thornton; Part II—Physical and Mechanical Properties of Centrispun Die Castings, J. I. Morley. Centrifugal Steel Castings for Gas Turbines, J. Taylor and D. H. Armitage. Investment-Casting of Nozzle Guide Vanes, H. E. Gresham and A. Dunlop. Precision-Casting of Turbine Blades, E. R. Gadd.

VI—Welding and Machinability Aspects: Welding of Heat-Resistant Alloys in Sheet Form, H. E. Lardge. Weld-Metal Properties and Welding Characteristics of Two Austenitic Steels Used for Gas-Turbine Rotors, E. Bishop and W. H. Bailey. Machining Austenitic and Ferritic Gas-Turbine Steels, K. J. B. Wolfe and P. Spear.

VII—Special Blade Materials. Chromium-Base Alloys for Gas-Turbine Applications, E. A. G. Liddiard and A. H. Sully. Some Cobalt-Rich Alloys for High-Temperature Service, J. C. Chaston and F. C. Child. Phase Diagrams of the Ternary Systems Fe-Cr-W and Fe-Cr-Mo at Low

Temperatures, H. J. Goldschmidt. Sintered Alloys for High-Temperature Service in Gas Turbines, R. W. A. Buswell, W. R. Pitkin, and I. Jenkins. Ceramics as Gas-Turbine Blade Materials: A Survey of the Possibilities, T. G. Carruthers and A. L. Roberts. Ceramics for Gas Turbines, L. Rotherham, W. Watt, J. P. Roberts, and F. J. Bradshaw. Sweat-Cooling: A Review of Present Knowledge and Its Application to the Gas Turbine, P. Grootenhuis and N. P. W. Moore.

VIII—Research and Future Needs: Research and Development on High-Temperature Materials, C. A. Bristow and H. Sutton. Future Needs in Materials for Land and Marine Gas Turbines, J. M. Robertson.

Discussion, Parts I—VIII. Some Turbine Problems in the Development of the Whittle Engine (5th Hatfield Memorial Lecture), Frank Whittle. Subject Index. Name Index.

Advanced Strength of Materials. J. P. Den Hartog. New York, McGraw-Hill Book Company, Inc., 1952. 379 pp., figs. $8.50.

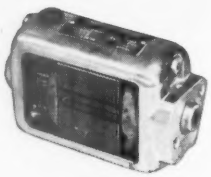
This book deals with materials covered in two courses at M.I.T., each of a semester's duration. The first of these, taken in the senior year, deals with Chapters 1, 2, 3, and 5, and the second, given as a graduate course, covers the remaining chapters. The book is not intended for a beginner; it is aimed at the student who has had the usual one-semester course in elementary strength of materials. In writing the text, the author has followed the notations of his previous elementary *Strength of Materials* and *Mechanics*, but the present book can be used after the study of any other elementary exposition. The book is specifically designed to bridge the gap between texts devoted to strength of materials and those dealing with theory of elasticity. Proofs and derivations are given for every proposition, and problems are included to be worked out by the student.

Contents: Chapter I, Torsion. Chapter II, Rotating Disks. Chapter III, Membrane Stresses in Shells. Chapter IV, Bending of Flat Plates. Chapter V, Beams on Elastic Foundation. Chapter VI, Two-Dimensional Theory of Elasticity. Chapter VII, The Energy Method. Chapter VIII, Buckling. Chapter IX, Miscellaneous Topics. Problems, Answers to Problems, and Index.

Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER
MOTORS

Proved DEPENDABILITY



Motor having substantial power output for computing machines and other types of motor-driven office equipment.

Successful operation in many thousand motor-driven products and devices—over a period of 36 years—has proved the thorough reliability of Lamb Electric Motors.

The good service for which Lamb Electric Motors are known, results largely from the fact that they are designed to provide the exact electrical and mechanical requirements for each product they drive.

This *special engineering* assures top *product* performance and usually results in savings in space, weight and cost factor. The Lamb Electric Company, Kent, Ohio.

Planetary inbuilt speed reducer permits a straight-line drive, symmetrical construction; insures good performance.

THEY'RE GOING INTO AMERICA'S *Finest* PRODUCTS

Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER MOTORS

NAVIGATION

Air Navigation, Theory and Practice. E. Brook Williams and W. J. V. Branch. London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corporation, 1952. 644 pp., figs. $12.50.

This work has been developed around the requirements of air-line personnel, whether they be specialist navigators or pilots responsible for their own navigation. In order that it may be useful to others, such as air-traffic controllers, flight operations officers, or dispatchers, it covers a fairly wide and advanced field. Navigation mathematics and algebra and trigonometry are covered. There are chapters on flight calculations, navigational instruments, radar and radio, D.R. Navigation, astronomical navigation, tides, magnetism, and flight planning, and an eight-page subject index. In order to meet the requirement of self-tuition, many worked examples and specimen questions, with answers, are given.

PHOTOGRAPHY

Handbook of Aerial Mapping and Photogrammetry. Lyle G. Trorey. 2nd Ed. Cambridge, at the University Press; New York, Cambridge University Press, 1952. 180 pp., illus., diagrs., figs. $6.00.

In the second edition of this manual, a new appendix gives details of the Kelsh plotter, a projection-type instrument with several new features, including a new system of illumination and a new method of compensation for sources of optical error. The author has taken the opportunity to correct misprints and errors and to add notes referring to latest knowledge.

PRODUCTION

Statistical Quality Control. Eugene L. Grant. 2nd Ed. New York, McGraw-Hill Book Company, Inc., 1952. 557 pp., diagrs., figs. $6.50.

The most important changes from the first edition are as follows: (1) The chapters dealing with acceptance sampling by attributes have been considerably expanded and largely rewritten. (2) The chapter dealing with acceptance sampling by variables has been entirely rewritten to include the Shainin Lot Plot and the Stanford variables tables and procedures. (3) The treatment of the cost aspects of quality decisions has been considerably expanded. (4) Less extensive changes have been made in the remainder of the book, which chiefly introduces new material. (5) The number of problems has been more than doubled; answers are now given to about 30 per cent of the problems. (6) The master tables from Military Standard 105A have been included in an appendix. Two tables for use in variables sampling have also been included—one giving representative factors from the Bowker-Goode volume, *Sampling Inspection by Variables*, and the other giving factors recently developed under Dr. Bowker's direction which make it possible to determine the approximate operating characteristics of a wide range of unknown-sigma plans for one-sided specifications.

SCIENCES, GENERAL

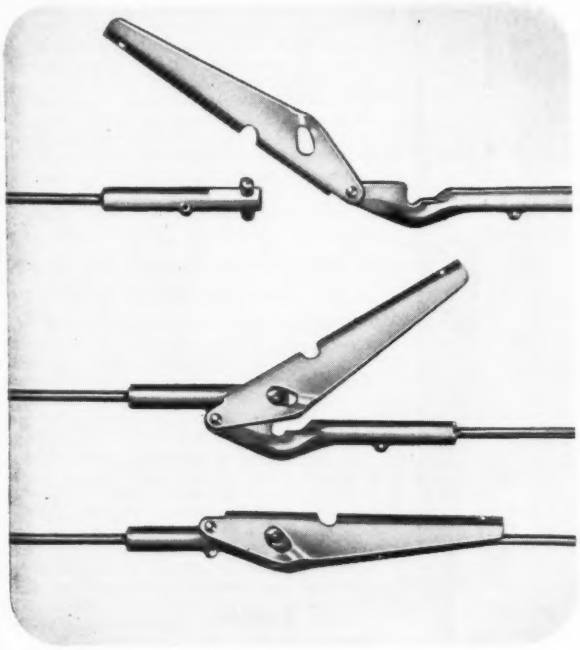
MATHEMATICS

Contributions to the Theory of Nonlinear Oscillations; Vol. 2. Edited by S. Lefschetz. (Annals of Mathematics Studies.) Princeton, N.J., Princeton University Press, 1952. 116 pp., figs. $1.50.

Contents: Van der Pol's Equation for Relaxation Oscillations, Mary L. Cartwright. Perturba-

Now You Can Disconnect and Restore Identical Aircraft Control Cable Tension in Seconds...with

SPEED-RIG



10 TIMES FASTER than existing turnbuckle installations. A flip of the handle and cable is disconnected. To immediately restore identical rig load, simply connect the unit, and close the high-leverage handle . . . it's that simple. With Speed-Rig, after adjusting cable to required tension with threaded shank, the turnbuckle ends remain permanently safety wired.

INTERCHANGEABLE: Speed-Rig is made to replace existing single barrel turnbuckles, without special tools. It comes in two types . . . standard, which fits existing turnbuckle terminals, and swage which may be swaged direct to the cable.

NO TOOL REQUIRED: The Speed-Rig handle serves as an inbuilt lever to adjust cable easily for correct tension.

SAFE: Rugged construction of high-test materials, yet light weight and small in size. Speed-Rig is made to withstand a minimum of 110% of cable strength. In use, handle is safety wired in closed position and cannot open if cable slackens.

AVAILABLE: Production units are now ready for standard cables 1/16″ through 3/16″.

TO AUTOMATICALLY RIG TO PREDETERMINED TENSION...USE AUTO-RIG

Auto-Rig is furnished in two types of fittings—plain ball or ball shank terminals, made for standard cables up to 3/32″. Cable take-up of 1″ with ultimate design load of 782 lbs. Auto-Rig is in production and is available for delivery.

Speed up engine change with *automatic* Auto-Rig which eliminates costly adjustment and lockwiring of throttle and carburetor control cable systems. Auto-Rig *automatically* rigs the cable to predetermined tension while it is being closed, connecting the two cable ends. Automatic safety is positive, indicated by red warning dots which show until Auto-Rig is properly closed. Auto-Rig cannot be over-rigged.

Competent aircraft control engineers are available to you for consultation and design assistance. Simply phone our nearest office.

Pacific SCIENTIFIC CO.

Los Angeles 23, Calif., 1430 Grande Vista Ave.
San Francisco 7, Calif., 25 Stillman St.
Seattle 4, Washington, 1915 1st Ave. South

EASTERN REPRESENTATIVE: Aero Engineering, Inc., 288 Old Country Rd., Mineola, L.I., N.Y. • 20 North Meridian Street, Indianapolis, Ind. • 10 South St., No. 30 Baltimore, Md. • Aero Sales Engineering Ltd., Montreal A.M.F., P.Q., Canada

INDUSTRIAL NOISE

can cost you money these 3 ways...

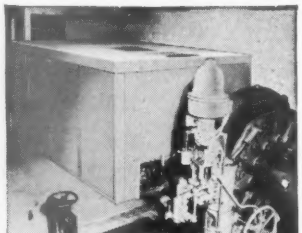
✓ **FIRST** . . . losses caused by worker fatigue, slowed reflexes, and nervous tension. These may show up in needless accidents, excessive spoilage, or communication errors.

✓ **SECOND** . . . losses due to industrial deafness claims. A substantial increase in claims and awards cannot help but increase your insurance costs.

✓ **THIRD** . . . losses caused by defending damage suits brought by your neighbors. Whether justified or not, these claims cost money to defend, and impair your public relations.

INDUSTRIAL SOUND CONTROL, Inc., can solve your problems by stopping noise at its source, through the use of sound traps, portable sound barriers, soundproofed rooms, and machinery enclosures, used singly or in combination. Let ISC, famous for "quieting anything that makes noise", protect you from these losses at surprisingly low cost.

Write today for free booklet "SOUND FACTS".



"Soundproofing a noisy pump or compressor with ISC 'Soundmetal' panels."

MIDWESTERN DISTRIBUTOR: Midwest Industrial Sound Control, Inc., 1455 North Pennsylvania Street, Indianapolis 2, Indiana.

SILENCE SERVICE

Industrial Sound Control Inc.

45 Granby Street, Hartford 12, Conn.

2119 SO. SEPULVEDA BLVD., LOS ANGELES, CALIF.

tions of Linear Systems with Constant Coefficients Possessing Periodic Solutions, E. A. Coddington and N. Levinson. Dynamical Systems with Stable Structures, H. F. DeBaggis. Notes on Differential Equations, Solomon Lefschetz. A Method for the Calculation of Limit Cycles by Successive Approximation, John McCarthy. Asymptotic Expansions of Solutions of Systems of Ordinary Linear Differential Equations Containing a Parameter, H. L. Turrittin.

✓ **Differential Equations.** Robert C. Yates. New York, McGraw-Hill Book Company, Inc., 1952. 215 pp., figs. $3.75.

This text is designed to prepare students for work in modern engineering practice and theory, to present the basic mathematical tools necessary for analysis and solution of problems leading to differential equations, and to stimulate a strong interest in the subject. The book ranges from ordinary first-order equations through the general linear ordinary equations with constant coefficients, special equations mostly of a nonlinear character, numerical solutions and solutions by series, and then to the solution of the wave equation by separation of variables. An account of Fourier series and their applications arises as a result of the consideration of certain simple boundary-value problems. Special topics presented include: Fourier solutions and expansions, approximate numerical solutions, wave equation and separation of variables, and many applications. Tables are given for indefinite integrals, gamma function values, and Bessel function values.

STRUCTURES

✓ **Theory of Elasticity and Plasticity.** H. M. Westergaard. (Harvard Monographs in Applied Science, No. 3.) Cambridge, Mass., Harvard University Press; New York, John Wiley & Sons, Inc., 1952. 176 pp., figs. $5.00.

This is an introduction to the theories of elasticity and plasticity which has been written from the point of view of the engineer although the treatment is entirely theoretical. An important feature is a historical chapter, which serves as a means of introducing many of the ideas that are later discussed in detail. Where necessary, the author has included full explanations of the mathematical processes that are employed and footnote references. The level of presentation is suitable for first-year graduate students of civil or mechanical engineering. At the time of his death in 1950, the author was Gordon McKay Professor of Civil Engineering at Harvard University.

THERMODYNAMICS

✓ **Thermodynamics and Statistical Mechanics.** William P. Allis and Melvin A. Herlin. New York, McGraw-Hill Book Company, Inc., 1952. 239 pp., figs. $6.00.

This book has been written as a text for seniors in physics at the Massachusetts Institute of Technology. Statistical mechanics is treated from the Boltzmann-Planck point of view, based on the classical mechanics of mass points and permutations among cells in phase space which turn out to have the size h^3. In thermodynamics, only two forces are included—hydrostatic pressure and magnetic fields. Magnetism has been treated in the part dealing with statistics because it offers a good example of order and disorder among dipole orientations. Only pure substances are considered, and, with that restriction, all discussion of chemical equilibria has been regretfully left out. On the other hand, an effort has been made not to overemphasize the ideal gas.

Contents: Part A, Heat and Thermodynamics. 1, Review of Mathematics. 2, The Equation of State. 3, The Gas Laws. 4, The First Law. 5, The Second Law of Thermodynamics. 6, Consequences of the second Law.

Part B, Statistical Mechanics. 7, Entropy and Probability. 8, Maxwell-Boltzmann Statistics. 9, Equipartition of Energy. 10, Quantum Statistics. 11, Degenerate Gases. Index.

Cutting Costs instead of Chips

GENERAL MOTORS engineers have come up with a new and extremely simple way of making turbine engine compressor blades that promises to save our country millions of dollars in man-hours, plant facilities, tools and critical materials.

This new method, developed by Delco-Remy Division in cooperation with Allison, is a cold-forming process that brings the projected cost down to a fraction of the present average cost of blades.

The full importance of this development in terms of our national economy is pointed up by the fact that a single jet engine may use as many as 6,000 blades.

Under blade-making methods now widely in use, excess stock is cut and machined away after high-alloy steel, rich in critical material, is forged or cast into the blade form. Delco-Remy, which has a world-wide reputation as an efficient mass producer of intricate automotive equipment, had learned how to cold-form metal by actually *pushing* it into shape, rather than cutting it.

In this way, nearly all of the material goes into the finished product and there is very little scrap from the manufacturing process. Delco-Remy engineers, in collaboration with Allison, adapted this method to blade processing. Blades made in this manner are rolled from cold flat strip stock with no chips to cut—thus saving valuable time in manufacture, as well as large quantities of precious material.

Blades produced by this process have been tested by Allison in T40 engines and their endurance characteristics have proved comparable to standard forged blades and to cast blades.

Developments like this help to explain why Allison turbine engines are produced at lower cost per pound of weight and per pound of thrust than any other turbine engines in the world.

And they offer further proof that Allison does make good use of its opportunity to draw on the special skills and experience of the entire General Motors organization — including the famed GM Technical Center in Detroit. This backing, plus its own vast engineering resources, provides Allison with unequaled facilities for truly advanced accomplishment in better—and less costly—gas turbine engines.

GM GENERAL MOTORS

Allison

DIVISION OF GENERAL MOTORS
INDIANAPOLIS, INDIANA

World's most experienced designer and builder of aircraft turbine engines

J35 and J71 Axial, J33 Centrifugal Turbo-Jet Engines, T38 and T40 Turbo-Prop Engines

ENGINEERS

FOR ATOMIC WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

LOCATE IN THE

Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area

THIS IS NOT A
CIVIL SERVICE APPOINTMENT

Make Application to the
PROFESSIONAL EMPLOYMENT DIVISION

SANDIA Corporation

SANDIA BASE
ALBUQUERQUE, N. M.

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Earl E. Morton, Chief of Aerodynamics. Has had many years of experience in aircraft manufacturing and was responsible for engineering on many now famous aircraft.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD *Aircraft Division*
HAGERSTOWN, MARYLAND

A LINK IN YOUR FUTURE

MECHANICAL DESIGN ENGINEERS

For engineers with experience in the design of small mechanisms, Link Aviation has an excellent opportunity.

Work involves design of newest flight simulators and forthcoming commercial products. Permanent position located in beautiful Southern Tier of New York.

Good housing available in suburban setting.

Ample company benefits.

Write full details to Manager of Industrial Relations.

LINK AVIATION, INC.
BINGHAMTON, N. Y.

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Mechanical Engineers—The advent of the flush-deck carrier and the high-performance jet aircraft produces new and exciting challenges in the field of catapult design. This is an expanding field where new ideas and original work will bear their mark on the future of Naval aviation. The Bureau of Aeronautics, accordingly, is seeking the services of qualified mechanical engineers with 3–10 years' experience for positions paying $5,000 to $8,000 per annum. Applicants should have a thorough knowledge of mechanics, structures, and thermodynamics. Those selected will be required to represent the Bureau of Aeronautics with contractors and other Government activities and, therefore, should possess a high degree of executive talent. Applicants should submit Standard Form 57, Application for Federal Employment (available at any Post Office), to Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention PE-22, Washington 25, D. C.

Aeronautical Engineers—Vacancies for aeronautical engineers exist in the Bureau of Aeronautics, Department of the Navy, Washington, D.C. Aerodynamic development engineers (performance) GS-11, $5,940 per annum; GS-9, $5,060 per annum; GS-7, $4,205 per annum; and GS-5, $3,410 per annum. Analysis and evaluation of performance characteristics of new aircraft designs, experimental- and service-type aircraft and proposed modifications thereto, including interpretation and application of results of laboratory tests affecting aircraft performance. Applicants should submit Standard Form 57, Application for Federal Employment (available at any Post Office), to Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention PE-22, Washington 25, D.C.

Dynamics Engineer—Opportunity to do research in aircraft flutter, vibration, aeroelasticity, and dynamic loading; 2–4 years' experience desired. Research Laboratories located on 4,000-acre ranch overlooking metropolitan San Antonio. Address replies to Engineering Mechanics Department, Southwest Research Institute, P.O. Box 2296, San Antonio, Tex.

Engineers—The Bureau of Aeronautics, Department of the Navy, Washington 25, D.C., announces the following openings. **Aeronautical Reseach, Development and Design Engineer,** GS-15, $10,800. Plan and coordinate programs for the development of guided missiles and target-type pilotless aircraft and their components; serve as principal guided missile consultant; assist in making budget estimates and allocation of allotted funds. **Metallurgist,** GS-12, $7,040. Research, development, and test of high-temperature resisting materials as related to production, operation, and maintenance of Naval aircraft. **Aircraft Modification Design Engineer,** GS-12, $7,040. Determine remedial measures for structure failure of Naval aircraft. Prepare design changes and initiate corrective action. **Aircraft Flutter and Vibration Engineer,** GS-11, GS-12, $5,940–7,040. Research and development in flutter, vibration, and structural dynamics; preparation and administration of technical specifications in these fields. **Electronics Engineer (Radio),** GS-12, $7,040. Research and development of landing aids equipments and systems; preparation and administration of technical specifications for same. **Materials Engineer (Textiles),** GS-11, $5,940. Development of flight and special protective clothing for aviation personnel; development of cordage, ropes, webbing, duck, and other fabrics used in Naval aircraft and components. **Mechanical Engineer,** GS-11, $5,040. Development of catapults and launchers for piloted aircraft and guided missiles. **Aeronautical Engineer,** GS-11, $5,040. Responsible for technical correctness of Pilot's Handbooks, Handbooks of Erection and Maintenance Instructions, and Operating and Service Instructions for Pilotless Aircraft and coordination of Handbooks of Instructions with Parts Catalog for special versions of Naval Aircraft. **Electronics Engineer,** GS-7, GS-11, $4,205–5,940. Research and development of armament control systems and components for aircraft fire control systems; primarily automatic control and servomechanism aspects. **Mechanical Engineer,** GS-9, $4,600. Prepare specifications, drawings, technical reports, technical notes and orders, aircraft bulletins, and aircraft service changes concerning cockpit and cabin enclosure equipment. This includes doors, hatches, flooring and flooring attachments, cargo and passenger-seat tie-down attachments, and interior and exterior attachment provisions that connect to, but do not form a part of, the primary aircraft structure. **Aeronautical Engineer,** GS-5, $3,410. General Calculations and studies in connection with engineering analysis of aircraft performance. **Aeronautical Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer research, design, development, and test of naval aircraft—heavier-than-air, airships, piloted aircraft, and guided missiles. Positions include specialists in performance, stability and control, structural development, loads, stress analysis, design, flutter and vibration, specifications writing, and weight control. Other positions concern the review of detailed aircraft design specifications, design proposals, and evaluation of reports. **General Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer research, design, engineering development, test, and installation of arresting and barrier gear, catapults, surface launchers, and launching devices. **Fire Control Design Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer research, development, design, engineering, and testing of fire control systems and equipment. **Power Plant Development Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer research, design, and development of aircraft engines and accessories. **Electronics Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer design, development, standardization, and installation of air-borne electronic equipment. Some positions concern maintenance and overhaul of AEW equipment, the initiation of aircraft service changes, technical orders, etc. **Mechanical Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Initiate and administer research, development, design, engineering, and testing of air-borne equipment, personal equipment, safety equipment, instruments navigation equipment, visual landing aids, and fog dispersal equipment. Some positions concern the maintenance and overhaul of naval aircraft or component parts, basic design of maintenance facilities, and ground-handling equipment. **Industrial Engineer,** all grades GS-5 to GS-12, $3,410–7,040. Render technical assistance on manufacturing methods and processes for production of aircraft and com-

DESIGNERS AVAILABLE

"CAL-AERO TECH" graduates are immediately useful without break-in...and dependable.

EXPERIENCE

4000 hours on board and in aircraft shops, with fundamentals and actual work assignments under supervision of Aircraft Factory Experienced Designers — specializing in design of component parts — proficient in layout, strength checking and manufacturing process analysis.

***New class graduates each month*—serving Douglas • North American • Boeing • Northrop • Curtiss-Wright • Lockheed Convair • Ryan • Airesearch • and many others.**

HIRE A "CAL-AERO" GRADUATE — HE'LL DELIVER THE GOODS

Phone or write

CAL-AERO TECHNICAL INSTITUTE

Grand Central Air Terminal — Glendale 1, California

PROJECT ENGINEER FOR

AUTOMATIC FLIGHT CONTROL DEVELOPMENT

Immediate position for a graduate engineer with a sound background of several years' experience in system engineering and flight controls. Knowledge of theory of aircraft stability and familiarity with computer analysis desirable. Long range program and expansion of facilities offer attractive opportunity to qualified person. Please submit resume covering engineering education and experience. Replies will be held strictly confidential.

LEAR, INC. *LearCal Division*

11916 West Pico Blvd. **Los Angeles 64, California**

ponents. To apply, send application form (SF-57) to Navy Department, Bureau of Aeronautics, Personnel Division (Aer-PE-22), 19th and Constitution Avenue, N.W., Washington 25, D.C.

Aeronautical Design Evaluation Engineer—Evaluation of aircraft equipment installations and systems and aircraft design for airworthiness certification and compliance with civil air regulations. Requirements: A degree in mechanical or aeronautical engineering plus 3½ years of aeronautical engineering experience. One year of this experience must have been in equipment systems such as hydraulics, pneumatics, pressurization, heating, and ventilating, plus either safety or miscellaneous equipment such as parachutes, flares, oxygen systems, fastening devices, etc. Salary, $7,040 per annum, with automatic increases. Address replies to: Miss R. A. Feeley, Chief, Personnel Branch, Civil Aeronautics Administration, New York International Airport, Jamaica, N.Y.

Electrical Engineer—Annual Salary of $5,940. Position involves conducting studies to determine suitability of aircraft electrical components and systems for use in manufacturing, repair, inspection, and maintenance of civil aircraft and the preparation of technical information and instructions covering electrical components and systems. Bachelor degree plus 3 years of progressive professional experience required. Lacking degree, equivalent combination of education and experience permitted. Applicants should submit Standard Form 57, Application for Federal Employment (available at any Post Office), to: Personnel Office, W-91.4, Civil Aeronautics Administration, 16th & Constitution Avenue, N.W., Washington, D.C.

438. Associate Professor or Professor—University in Midwest has opening for Ph.D. with interest in Aircraft Propulsion to teach undergraduate Aeronautical and Mechanical Engineering courses and to conduct sponsored research. Extensive laboratory facilities available. Title and salary commensurate with qualifications.

436. Engineer-Accountant—Expanding Westchester aeronautical firm has staff position open as Assistant to the President for young man with both theoretical engineering and accounting background. From 2–5 years' industrial experience is desired.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

432. Editor or Literature Scientist—To handle technical literature in foreign languages including French, German, Italian, Russian, etc. Salary commensurate with experience and ability. Permanent position with established organization. Desirable personnel benefits. For further information or interview, reply giving age, complete résumé of education, experience, and other pertinent data.

Available

440. Aero-Mechanical Engineer—B.M.E., age 33. Eleven years' experience in the aircraft industry comprising guided missile electromechanical systems development, flight-test research, and stress analysis. Three most recent years in supervision as assistant project electromechanical engineer and project test engineer. Experience includes directing electrical system design, environmental test program, booster rocket installation design, test equipment design, flight-test programs. Familiar with military specifications. Seeking supervisory or administrative position in aircraft, missile, or allied field in New York City area only. Will furnish résumés upon request. Please indicate nature of available positions in first letter.

439. Representative or Government Contract Administrator—B.A. and M.B.A. degrees. Fourteen years' aviation experience: production specialist and buyer, Wright Field; assistant director—export sales, prominent aircraft manufacturer, etc. World War II test pilot and Air Force Factory Representative. Desires affiliation with aviation division of commercial equipment organization. Opportunity important. Current salary $7,000. Brochure upon request.

435. Aeronautical Engineer—B.S.A.E. Approximately 6 years' engineering experience, including aircraft hydraulics systems and missile development; currently associated with noted firm as development engineer on aircraft instruments. Captain, U.S.A.F.R., Aeronautical Research and Development Officer. Current military and civil pilot ratings. Desires position in supervisory capacity or responsible position with definite avenues of progress. Midwest, Southwest, or Western location preferred. If possible, state nature of position in originating correspondence.

434. Staff Engineer—Eleven years' well-rounded aircraft experience, including stress, liaison, design, production design, and U.S.A.F. procurement and maintenance engineering. Primary emphasis has been on coordination and staff trouble-shooting work. Currently on project staff assignment with aircraft manufacturer. Prefers West Coast. Please state your requirements in first letter.

433. Aeronautical Engineer—Age 48. Unusual background of practical experience in the production of precision products, welded products, and aircraft fabrication. Excellent background in the design and development of aircraft and aircraft-type structures in both aluminum and magnesium alloys. Well-versed in production planning, processing, tooling, and quality control. Excellent supervisory record in the foregoing in both the aircraft and automotive industries. Desires responsible position as production manager, superintendent, master mechanic, or similar capacity in the aircraft or an allied industry. Will consider substantial investment in reliable concern. West Coast location preferred.

431. Rotary-Wing Engineer—M.S. Desires responsible position in rotary-wing industry. Thirteen years' engineering experience: 9 years in helicopter engineering and 4 years in propeller engineering. Currently, head of rotary-wing flight-test engineering with military establishment. Well-grounded in theory of performance and flight-handling qualities, specifications, development, and test. Request complete detail first letter.

Special I.A.S. Publications

	Member Rate	Nonmember Rate
Aeronautical Engineering Index – 1951	$ 3.00	$ 5.00*
1950	2.50	4.00*
1949, 1948, 1947	2.00	3.00*
Second International Aeronautical Conference Proceedings	15.00	17.50*
First Convertible Aircraft Congress Proceedings	3.00	5.00*
Fifteenth Wright Brothers Lecture—The Experimental Approach to Aircraft Structural Research, P. B. Walker (Reprinted from the March, 1952, and April, 1952, JOURNAL OF THE AERONAUTICAL SCIENCES)	1.00	1.50
The Earth's Atmosphere, H. E. Roberts, including 20- by 16-in. colored chart (Reprinted from the October, 1949, AERONAUTICAL ENGINEERING REVIEW)	0.65	1.00

*Add $1.00 for orders outside the U.S.A.

These may be obtained by writing to

Publications Department, Institute of the Aeronautical Sciences, Inc., 2 E. 64th St., New York 21, N.Y.

This is the Boeing team's jet heavyweight

Here is a flight shot of the giant Boeing B-52 Stratofortress. An eight-jet heavy bomber, the Stratofort is a fast, husky teammate to the B-47 Stratojet medium bomber. It's 153 feet long, measures 185 feet from wing-tip to wing-tip, and is powered by eight Pratt & Whitney J-57 engines. Speed and other performance details are carefully guarded secrets.

This Boeing jet-bomber team is just another example of the trail-blazing that, over the past 35 years, has kept Boeing engineers at the head of the design parade.

If you measure up to Boeing standards, you can share this Boeing prestige. You'll work with men renowned in their fields, on such challenging projects as guided missiles, nuclear-powered aircraft, and the exploration of supersonic flight.

There are openings at Boeing right now for experienced and junior engineers in all fields, for aircraft

- **DESIGN**
- **DEVELOPMENT**
- **RESEARCH**
- **PRODUCTION**
- **TOOLING**

also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

You can work in Seattle in the Pacific Northwest or, if you prefer, at Wichita in the Midwest. Boeing provides a generous moving and travel allowance, offers you special training, a salary that grows with you—and a future of almost limitless range.

You'll be proud when you say, "I'm a Boeing engineer!"

Write today to the address below, or use the convenient coupon

JOHN C. SANDERS, Staff Engineer—Personnel
Dept. W-12
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

*Name*_____

*Address*_____

*City and State*_____

BOEING

Frankly, working at North American requires hard thinking and plenty of vision. Because North American always works in the future. Yet, if you are interested in advanced thinking, if you'd like to work on the planes that will make tomorrow's aviation history, you'll like working at North American. North American offers these extra benefits, too.

North American Extras—

Salaries commensurate with ability and experience • Paid vacations • A growing organization • Complete employee service program • Cost of living bonuses • Six paid holidays a year • Finest facilities and equipment • Excellent opportunities for advancement • Group insurance including family plan • Paid sick leave • Transportation and moving allowances • Educational refund program • Low cost group health (including family) and accident and life insurance • A company 24 years young.

Write Today

Please write us for complete information on career opportunities at North American. Include a summary of your education, background and experience.

CHECK THESE OPPORTUNITIES AT North American

- Aerodynamicists
- Stress Engineers
- Aircraft Designers and Draftsmen
- Specialists in all fields of aircraft engineering
- Recent engineering graduates
- Engineers with skills adaptable to aircraft engineering

NORTH AMERICAN AVIATION, INC.

Dept. 1, Engineering Personnel Office
Los Angeles International Airport
Los Angeles 45, Calif.; Columbus 16, Ohio

North American Has Built More Airplanes Than Any Other Company In The World

THE NEW SCIENTIFIC RESEARCH LABORATORY OF THE FORD MOTOR COMPANY

has openings for

Aerodynamic
Combustion
Heat Transfer
Control
Design
} Engineers

to research, design and develop automotive gas turbine propulsion systems.

Qualifications:

BS in ME or Aero. E. with advanced degree or courses in mathematics, fluid mechanics or servo-mechanisms or heat transfer or combustion. A minimum of 5 years' experience in research and design of gas turbine propulsion components and systems.

FORD MOTOR COMPANY
Engineering Personnel
Oakwood Boulevard
West Dearborn, Michigan

TRANSONICS
SUPERSONICS
HYPERSONICS

Unusual opportunities for engineering specialists to associate with established firm in the design and development of the world's largest high speed test facilities and other interesting projects.

Transfers to operational phase optional as construction progresses.

Positions also available for Mechanical, Electrical, Instrumentation, and Structural Engineers.

SVERDRUP & PARCEL, INC.
Consulting Engineers
915 Olive St. St. Louis 1, Missouri

Aerophysicists, Designers, Engineers

YOUR IDEAS WILL COUNT AT NORTH AMERICAN

North American encourages advanced thinking, because they know looking ahead is the only way to maintain leadership in the aviation industry. That's why North American needs men of vision. If you like hard thinking and would like to work for a company that will make the most of your ideas, you'll find real career opportunities at North American. North American offers you many extra benefits, too.

North American Extras—

Salaries commensurate with ability and experience • Paid vacations • A growing organization • Complete employee service program • Cost of living bonuses • Six paid holidays a year • Finest facilities and equipment • Excellent opportunities for advancement • Group insurance including family plan • Paid sick leave • Transportation and moving allowances • Educational refund program • Low-cost group health (including family) and accident and life insurance • A company 24 years young.

Write Today

Please write us for complete information on career opportunities at North American. Include a summary of your education, background and experience.

IS YOUR FIELD LISTED HERE ?

- Airborne Electronic Equipment
- Equipment Flight Tests
- Precision Instruments
- Automatic Controls
- Propulsion Systems
- Servo-Mechanisms
- Airframe Studies
- Radar Devices
- Instrumentation
- Micro Wave Techniques
- Metallurgical
- Electroplating
- Engineering Planning

NORTH AMERICAN AVIATION, INC.

Aerophysics, Electro-Mechanical Research Division

Dept. 1, Personnel Section,
12214 Lakewood Blvd., Downey, California

North American Has Built More Airplanes Than Any Other Company In The World

AERONAUTICAL RESEARCH

IF—you would like to join the staff of a stable, highly competent applied research organization . . .

IF—you have imagination, initiative, curiosity, education and ambition . . .

IF—you enjoy working on challenging problems with leaders of aeronautical research . . .

THEN—we cordially invite you to contact us to obtain further information.

Typical fields of research in aeronautics include large scale wind tunnel testing, aeroelasticity (throughout the subsonic, transonic and supersonic regions), missiles, automatic stability and control of fixed and rotating wing aircraft, structural analysis and composite design.

A booklet describing the facilities, activities and interests of the laboratory has been made available for free distribution. We would be pleased to mail you one upon request.

P.O. BOX 235

BUFFALO 21, NEW YORK

CORNELL AERONAUTICAL LABORATORY, INC.

DESIGN STAFF ENGINEER

Transmission

BROAD experience in precision automotive transmission design, including extensive background in manufacturing operations. Helicopter or aircraft experience desired. Responsible for transmission design at staff level; and, to coordinate design problems with vendor manufacturers. A degree in mechanical engineering is preferred. However, equivalent experience will be accepted.

DESIGN STAFF ENGINEER

Electrical

BROAD experience in aircraft electrical systems. Aircraft experience required. Experience in electronic systems including auto-pilot and radio desirable. Administrative ability and experience which will enable the individual to direct activities of a small design staff, coordinating all electrical and electronic activities within a large aircraft engineering department. Degree in electrical engineering preferred. However, equivalent experience will be accepted.

INDUSTRIAL ENGINEERS

INDUSTRIAL or mechanical engineering degree or equivalent, plus experience in analyzing manufacturing problems related to methods (direct and/or indirect), plant layout processing, tooling and cost reduction.

HELICOPTER TEST PILOTS

With not less than 250 Hours of Helicopter Time

A-l-s-o

DRAFTSMEN

With two to five years' experience, preferably in aircraft.

Send complete resume, including salary requirements to EMPLOYMENT MANAGER

PIASECKI

Helicopter Corp.

Department "B"

Morton, Pa., A Phila. Suburb

Flight Test Opportunities

for

- **EXPERIENCED FLIGHT TEST INSTRUMENTATION ENGINEERS**
- **FLIGHT TEST ENGINEERS**
- **FLIGHT TEST ANALYSTS**

Dealing with

- **GUIDED MISSILES**
- **AIRPLANE SYSTEMS**
- **AUTOPILOTS**

The Missile and Control Equipment Laboratory of North American Aviation has openings in its flight test organization to handle flight testing of guided missiles and electronic control systems.

Excellent opportunities are offered for experienced engineers and analysts with airplane and guided missile flight test and flight test instrumentation background.

Outstanding opportunities are available on a long-range development program on basic guided missile work.

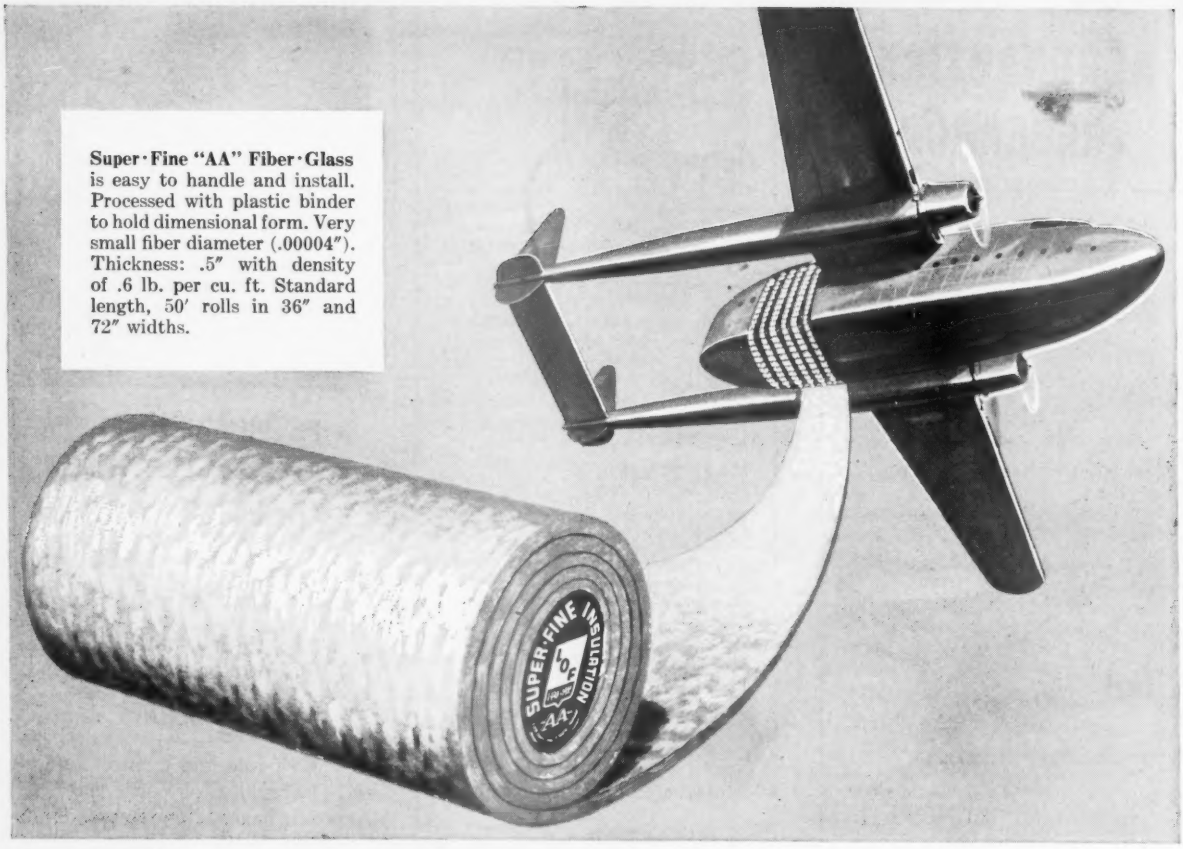
- **SALARIES COMMENSURATE WITH TRAINING AND EXPERIENCE**
- **EXCELLENT WORKING CONDITIONS**
- **FINEST FACILITIES AND EQUIPMENT**

Write now.
Give complete resume of education, background and experience.

NORTH AMERICAN AVIATION, INC.

Engineering Personnel Department
Missile and Control Equipment Laboratory

12214 LAKEWOOD BLVD.
DOWNEY, CALIFORNIA



Super·Fine "AA" Fiber·Glass is easy to handle and install. Processed with plastic binder to hold dimensional form. Very small fiber diameter (.00004″). Thickness: .5″ with density of .6 lb. per cu. ft. Standard length, 50′ rolls in 36″ and 72″ widths.

How to warm up an airplane

L·O·F offers highly efficient Fiber·Glass sound and thermal insulation

Made primarily for aircraft, L·O·F Super·Fine "AA" Fiber·Glass keeps plane interiors well insulated even at frigid, high-altitude temperatures, and muffles engine roar and other annoying sounds. A thickness of as little as a half inch insulates with high efficiency.

L·O·F Fiber·Glass is lightweight, yet does not shake down under vibration. It has low moisture pickup; will not support fungi, will not rot. And it is fire-resistant, vitally important for military planes. L·O·F Fiber·Glass, meeting all applicable Government and commercial standards, is delivered *right on schedule.*

Why not talk over your insulation problems with us? And investigate, too, Garan-treated Fiber·Glass for reinforced plastic parts, such as radomes, aircraft structural parts and electronic equipment. It provides outstanding flexural and compressive strength and increased translucency. Just call your local L·O·F office (district offices in 26 major cities), or write, wire or phone Libbey·Owens·Ford Glass Company, Dept. F·G 9122, Nicholas Bldg., Toledo 3, Ohio.

LOF GLASS PLASKON FIBER·GLASS

LIBBEY·OWENS·FORD GLASS COMPANY
FIBER·GLASS DIVISION

FIBER·GLASS

Index to the

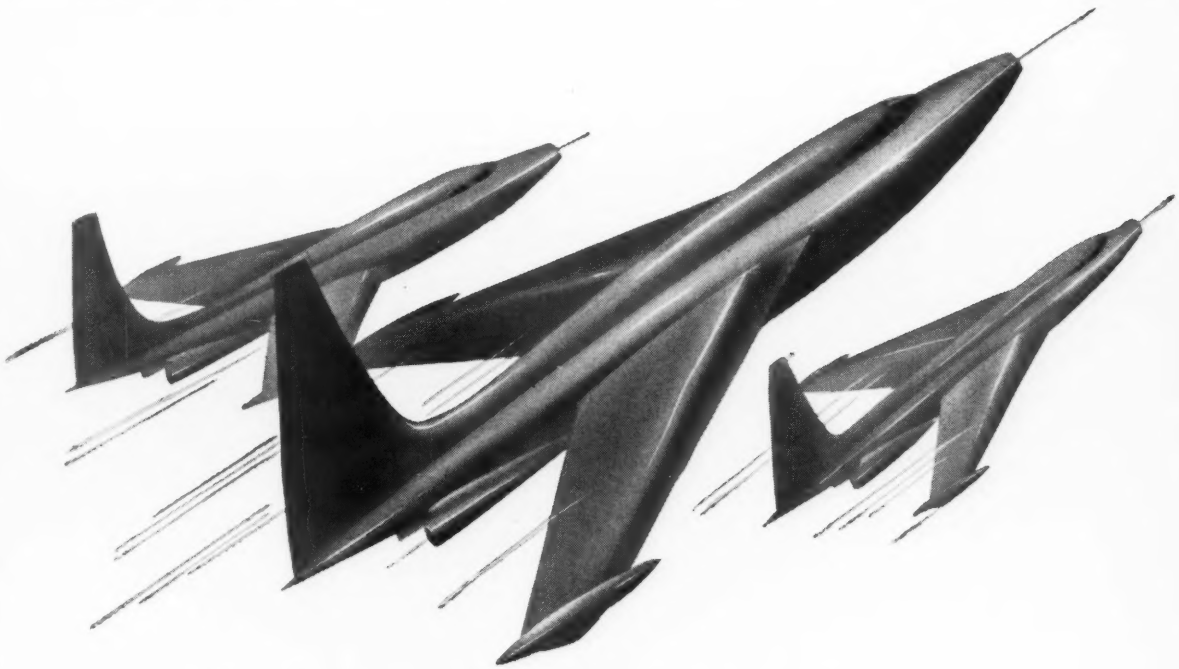
Aeronautical Engineering Review, Volume 11

January–December, 1952

	Month	Page
Aerodynamics—		
Boundary-Layer Studies on a Sailplane, August Raspet	*June*	52
Air Transport—		
The Air-Line Pilots Look at Safety, Capt. William W. Moss	*Apr.*	46
The Air Transport Business—from the British Point of View, Peter G. Masefield	*Apr.*	61
Economic Aspects of the Supersonic Jet Transport, Robert E. Hage and Richard D. FitzSimmons	*Sept.*	42
ALDEN, JOHN H., AND JOHN F. FAULKNER. New Components for Air-Frame Construction	*Oct.*	28
American Helicopter Society—		
A.H.S. News.....*Jan.*, 40; *Feb.*, 46; *Mar.*, 61; *June*, 68; *July*, 58; *Sept.*, 59; *Oct.*, 66; *Nov.*, 18	*Dec.*	46
ANAST, CAPT. JAMES L. Automatic Flight Control	*May*	26
Antenna systems, aircraft, design limitations on	*May*	82
APPLEMAN, H. The Forecasting of Jet-Aircraft Condensation Trails	*Aug.*	30
ARNOLD, BRIG. GEN. MILTON W. The All-Weather Program as Affected by Design of Electronic Equipment	*May*	55
Atomic power, the promise and problems of	*Aug.*	22
Automatic Control—		
Automatic Flight Control, Capt. James L. Anast.	*May*	26
BEALS, LYNN S., JR. Integrated Instrumentation for Modern Aircraft	*May*	50
BENSEN, IGOR B. The Pressure-Jet Helicopter—Performance Data and Operating Experience	*June*	41
BERMAN, SIDNEY D. Safety in Design	*July*	34
BINDER, RAY C., HAROLD M. DEGROFF, JOHN G. TRUXAL, AND J. ROBERT BURNETT. Fundamental Aspects of a Hydraulic-Type-Powered Flight-Control System	*Nov.*	42
Boundary-layer studies on a sailplane	*June*	52
BOWLER, E. H., D. FRASER, AND K. G. PETTIT. Criteria for the Design, Assessment, and Control of Icing Protection Systems	*July*	44
BRADY, GEORGE W. The High-Speed Propeller	*July*	22
BRIDGEMAN, WILLIAM B. Supersonic Flight from the Pilot's View	*Feb.*	24
BROOKS, M., R. C. TRESEDER, AND J. R. KESSLER. The Effect of Propeller-Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency	*Nov.*	29
BULLIVANT, W. KENNETH. Theory of Operation of the Vane-Type Prestall Detector	*Feb.*	39
BURNETT, J. ROBERT, HAROLD M. DEGROFF, RAY C. BINDER, AND JOHN G. TRUXAL. Fundamental Aspects of a Hydraulic-Type-Powered Flight-Control System	*Nov.*	42
CAMPBELL ORDE, A. C. Some Practical Experience with Civil Jet Transport Operation and Associated Meteorological Problems	*Mar.*	47
CARMICHAEL, B. H. Cross-Country Soaring Criteria Based on Thermal Strength	*July*	39
CLIETT, CHARLES B. Flexural Fatigue Strength of Anodized 24ST Aluminum-Alloy Sheet	*Dec.*	29
Cockpit design, functional	*June*	32
Cockpit design and safety	*Oct.*	36
COCKRELL, WILLIAM S. Titanium	*Mar.*	44
Control system, the F-89 Scorpion, a feature of, deceleron	*Mar.*	34
Control system, hydraulic-type-powered flight-, fundamental aspects of a	*Nov.*	42
Core material, low-density, in aircraft structures, use of a	*Sept.*	52
CRAIGIE, GEN. LAURENCE C. The Air War in Korea	*June*	26
Deceleron—a feature of the F-89 Scorpion control system	*Mar.*	34
DEGROFF, HAROLD M., RAY C. BINDER, JOHN G. TRUXAL, AND J. ROBERT BURNETT. Fundamental Aspects of a Hydraulic-Type-Powered Flight-Control System	*Nov.*	42
Design—		
The Airplane Growth Factor and How to Control It, Ivan H. Driggs	*Sept.*	28
Cockpit Design and Safety, William I. Stieglitz	*Oct.*	36
Deceleron—A Feature of the F-89 Scorpion Control System, Boyd Richardson	*Mar.*	34
Design Limitations on Aircraft Antenna Systems, J. V. N. Granger	*May*	82
Functional Cockpit Design, Barry G. King	*June*	32
Fundamental Aspects of a Hydraulic-Type-Powered Flight-Control System, Harold M. DeGroff, Ray C. Binder, John G. Truxal, and J. Robert Burnett	*Nov.*	42
New Components for Air-Frame Construction, John F. Faulkner and John H. Alden	*Oct.*	28
Radomes and Aircraft Design, Ernest W. Schlieben	*May*	69
Safety in Design, Sidney D. Berman	*July*	34
Some Aspects of the Aircraft Noise Problem, Harvey H. Hubbard and Leslie W. Lassiter	*July*	28
The Turboprop Airplane, William W. Fox	*June*	22
DRIGGS, IVAN H. The Airplane Growth Factor and How to Control It	*Sept.*	28
Editorial—		
Aeronautics—Some Social Aspects, Dr. Jerome C. Hunsaker	*Dec.*	20
The Commission Recommends	*July*	20
Fall Forecast	*Nov.*	20
The Fastest Ten Years in History	*June*	21
Fourth International Aeronautical Conference	*Nov.*	21
1951 Honorary Fellows	*Feb.*	22
1951 I.A.S. President—1952 I.A.S. President	*Jan.*	8

	Month	Page
"Is There an Idea in the House—?" The Hon. Dan A. Kimball	*Sept.*	20
One Task Before Us, Wellwood E. Beall	*Apr.*	22
A Revolution in Technique, Charles E. Wilson	*Mar.*	30
Synthetic Training	*Aug.*	21
The Tail That Wags the Dog	*May*	24
Vocational Guidance Plan	*Oct.*	20
Electronics—		
Airport Taxi Radar	*May*	32
All-Weather Operation Problems (Electronics in Aviation Symposium), D. S. Little	*May*	46
The All-Weather Program as Affected by Design of Electronic Equipment, Brig. Gen. Milton W. Arnold	*May*	55
Automatic Flight Control, Capt. James L. Anast	*May*	26
Design Limitations on Aircraft Antenna Systems, J. V. N. Granger	*May*	82
Electronic Controls as Applied to Aircraft Inverters, B. M. Starr	*Aug.*	36
Heat-Transfer Design Problems in Aircraft Electronic Equipment, Leonhard Katz	*May*	61
Integrated Instrumentation for Modern Aircraft, Lynn S. Beals, Jr.	*May*	50
Present Status of Transistor Development, J. B. Morton	*May*	34
Radomes and Aircraft Design, Ernest W. Schlieben	*May*	69
Storm and Clear Air Turbulence, A. F. Merewether and F. C. White	*May*	57
ELLISON, JOHN M., AND RAYMOND J. MOORE. Use of a Low-Density Core Material in Aircraft Structures	*Sept.*	52
Engineers for the U.S.A.F., Major Robert R. Lent	*Jan.*	26
FALCONER, R. W. The Application of Jet Propulsion to Helicopters	*Sept.*	46
FANGEMANN, M. GERARD. Temperature-Compensated Springs for Aircraft Application	*Aug.*	42
FAULKNER, JOHN F., AND JOHN H. ALDEN. New Components for Air-Frame Construction	*Oct.*	28
Fish, large salt-water, power and efficiency of	*Jan.*	10
FITZSIMMONS, RICHARD D., AND ROBERT E. HAGE. Economic Aspects of the Supersonic Jet Transport	*Sept.*	42
Flight Propulsion—		
Aircraft Nuclear Propulsion, M. C. Leverett	*Jan.*	29
The Application of Jet Propulsion to Helicopters, R. W. Falconer	*Sept.*	46
The Effect of Propeller-Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency, R. C. Treseder, M. Brooks, and J. R. Kessler	*Nov.*	29
Flight Testing and Operational Problems on an Afterburner-Equipped Turbojet Installation, R. R. Templeton	*Dec.*	32
Helicopter Transmissions—Weight vs. Cost, Thomas J. Harriman	*Aug.*	33
Liquid-Coupled Regenerators for Turboprops, A. L. London and W. M. Kays	*Oct.*	42
On the Interaction Between Multiple Jets and an Adjacent Surface, Julius Jonas	*Jan*	21
Power and Efficiency of Large Salt-Water Fish, D. R. Gero	*Jan.*	10
The Promise and Problems of Atomic Power, Gale Young	*Aug.*	22
The Shock Ignition Engine, Frank F. Rand, Jr.	*Oct.*	22
Flight Safety—		
The Air-Line Pilots Look at Safety, Capt. William W. Moss	*Apr.*	46
All-Weather Operation Problems (Electronics in Aviation Symposium), D. S. Little	*May*	46
The All-Weather Program as Affected by Design of Electronic Equipment, Brig. Gen. Milton W. Arnold	*May*	55
Cockpit Design and Safety, William I. Stieglitz	*Oct.*	36
Reduction of Gun-Gas Explosion Hazard in Combat Aircraft, J. J. Horan, J. R. Onderdonk, and E. Witkin	*Mar.*	37
Safety in Design, Sidney D. Berman	*July*	34
Flight testing and operational problems on an afterburner-equipped turbojet installation	*Dec.*	32
FOX, WILLIAM W. The Turboprop Airplane	*June*	22
FRASER, D., K. G. PETTIT, AND E. H. BOWLER. Criteria for the Design, Assessment, and Control of Icing Protection Systems	*July*	44
GERO, D. R. Power and Efficiency of Large Salt-Water Fish	*Jan.*	10
Gliding and Soaring—		
Boundary-Layer Studies on a Sailplane, August Raspet	*June*	52
Cross-Country Soaring Criteria Based on Thermal Strength, B. H. Carmichael	*July*	39
On the Possibility of Soaring on Traveling Waves in the Jet Stream, Joachim P. Kuettner	*Dec.*	22
GOLDIN, ROBERT. Pilotless Aircraft—The Establishment of Structural Design Criteria	*Nov.*	22
GRANGER, J. V. N. Design Limitations on Aircraft Antenna Systems	*May*	82
Gun-gas explosion hazard in combat aircraft, reduction of	*Mar.*	37
HAGE, ROBERT E., AND RICHARD D. FITZSIMMONS. Economic Aspects of the Supersonic Jet Transport	*Sept.*	42
HARRIMAN, THOMAS J. Helicopter Transmissions—Weight vs. Cost	*Aug.*	33
Heat-transfer design problems in aircraft electronic equipment	*May*	61
Helicopters—		
The Application of Jet Propulsion to Helicopters, R. W. Falconer	*Sept.*	46
Helicopter Transmissions—Weight vs. Cost, Thomas J. Harriman	*Aug.*	33
The Pressure-Jet Helicopter—Performance Data and Operating Experience, Igor B. Bensen	*June*	41
HORAN, J. J., J. R. ONDERDONK, AND E. WITKIN. Reduction of Gun-Gas Explosion Hazard in Combat Aircraft	*Mar.*	37
HUBBARD, HARVEY H., AND LESLIE W. LASSITER. Some Aspects of the Aircraft Noise Problem	*July*	28
Hydraulic-type-powered flight-control system, fundamental aspects of a	*Nov.*	42
Icing—		
Criteria for the Design, Assessment, and Control of Icing Protection Systems, D. Fraser, K. G. Pettit, and E. H. Bowler	*July*	44
The Physics of the Mechanical Removal of Ice from Aircraft, D. L. Loughborough	*Feb.*	29
Institute of the Aeronautical Sciences—		
Aeronautical Engineering Catalog Available	*June*	66
Aeronautical Structures Laboratory at Columbia	*Oct.*	18
A.I.A. Elects Officers for 1952	*Feb.*	20
Air-Line Official to Deliver 1952 Wright Brothers Lecture (William Littlewood)	*Oct.*	17
Air Safety Awards Presented	*May*	22

MAGNESIUM



IS GOING PLACES!

Magnesium, the world's lightest structural metal, has kept pace with the tremendous progress in aircraft design. In the past decade, startling design improvements have been made—improvements depending upon the inherent advantages of magnesium. Where 1,000 lb. of this ultra light metal were used in the 1940 bomber—now 15,000 to 25,000 lb. are used.

Today it is found in almost every part of these planes in the form of sheet, castings, extrusions and forgings. By this extensive use of magnesium the weight of today's bomber is as much as three and one-half tons less than it would have been had other metals been used throughout. Cutting pounds off the weight without sacrificing strength, magnesium has made possible the addition of extra features, more payload or greater flying range.

A vital metal in air transportation today, magnesium offers even greater design potentialities for tomorrow. If your aim is light weight, keep your eye on magnesium.

MAGNESIUM USED IN 1951 AIRCRAFT:

Fuselage skins
Wing skins, including de-icer system
Control surface skins
Flooring extrusions
Bomb bay doors
Propeller spinners
Waffle grid stiffeners
Formers and air ducts
Nacelle skins
Wheels, brakes, gun turrets
Radar, radio and fire control equipment
Engine castings
Airframe castings

THE DOW CHEMICAL COMPANY

Magnesium Department • *Midland, Michigan*

New York • Boston • Philadelphia • Atlanta • Cleveland • Detroit • Chicago • St. Louis • Houston
San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada

	Month	Page
American Engineers Win Trophy	*Dec.*	17
Annual Business Meeting of the Institute	*Mar.*	23
Annual Summer Meeting Dinner	*Sept.*	16
Annual Summer Meeting Largest Yet	*Sept.*	15
A.R.D.C. Publishes Contractors' Guide	*Dec.*	19
Arde Associates Joins I.A.S.	*June*	18
Dr. B. A. Bakhmeteff Service	*Jan.*	6
Bane and Chanute Awards Presented	*Aug.*	17
W. E. Beall to Serve as 1952 I.A.S. President	*Jan.*	5
Collier Trophy Awarded	*Feb.*	20
Comments on Twentieth Annual Meeting	*Mar.*	19
Consultants and Designers, Inc., Joins I.A.S.	*Jan.*	6
Corporate Member Air Carriers Receive Awards	*Sept.*	19
Director's Report	*Mar.*	24
Doolittle Reports	*July*	17
G. H. Dowty, R.Ae.S. President; I.A.S. Members Among R.Ae.S. Award Winners	*Aug.*	19
Fifteenth Wright Brothers Lecture Presented	*Feb.*	19
Financial Statement	*Mar.*	25
Flight Propulsion Meeting Marked Success	*May*	21
L. D. Gardner Receives M.I.T. Award	*May*	22
1952 Guggenheim Jet Propulsion Fellows	*Sept.*	19
1952 Guggenheim Medalist (Sir Geoffrey de Havilland)	*Oct.*	18
1952 Guggenheim Medalist—Erratum	*Nov.*	18
Heat Transfer Symposium	*June*	66
How to Prepare Slides	*Feb.*	21
I.A.S. Awards and Honors for 1951	*Mar.*	20
I.A.S. Corporate Members Win Awards	*Jan.*	6
I.A.S. Corporate Members Win Safety Contest	*May*	22
I.A.S. Cosponsors Heavy Forgings and Extrusions Symposium on December 2	*Sept.*	18
I.A.S. Fellows for 1952	*Mar.*	22
I.A.S. Group Visits Eglin A.F.B.	*Apr.*	19
I.A.S. Members on Columbia University Committee	*Mar.*	28
I.A.S. Members Elected to Flight Safety Foundation's Board; Foundation Plans Expanded Safety Program	*Aug.*	54
I.A.S. Members Inducted as S.A.E. Officers	*Mar.*	28
I.A.S. on P.A.C.	*Apr.*	20
1951 I.A.S. President Joins Electric Boat	*Mar.*	28
I.A.S. Twenty-First Annual Meeting	*Nov.*	17
I.A.S. Welcomes Two New Corporate Members	*Apr.*	21
N.A.C.A. Honors John Jay Ide	*June*	18
N.A.C.A. Positions Opened	*Feb.*	20
N.A.C.A. Technical Committees Named	*Apr.*	21
Naval Symposium on Jet Airfields	*Mar.*	28
New Corporate Member	*Oct.*	64
New Engineering Center Planned	*Jan.*	6
New York Airways Begins Mail Service; I.A.S. Members on Board of Directors	*Dec.*	18
Newly Elected Members of the Institute Council	*Mar.*	26
Preliminary Announcement of the 1952 Annual Summer Meeting	*June*	17
President's Report	*Mar.*	23
A Revision of Letter Symbols for Hydraulics	*Jan.*	6
R.P.I.'s Wind Tunnel	*Mar.*	28
Supersonic Tunnel at Brooklyn	*May*	22
A Synopsis of the Technical Sessions at the 20th Annual Meeting	*Apr.*	24
Tentative Program of the 1952 Summer Annual Meeting	*June*	18
Third Southeastern Regional Conference	*Aug.*	19
Treasurer's Report	*Mar.*	24
The Arnold Dwight Tuttle Award	*June*	66
Two New Corporate Members	*Nov.*	18
West Coast Student Conference	*Sept.*	18
1951 Wright Trophy Winner (Dr. J. C. Hunsaker)	*Jan.*	7

	Month	Page
Instruments—		
Integrated Instrumentation for Modern Aircraft, Lynn S. Beals, Jr.	*May*	50
Temperature-Compensated Springs for Aircraft Application, M. Gerard Fangemann	*Aug.*	42
Theory of Operation of the Vane-Type Prestall Detector, W. Kenneth Bullivant	*Feb.*	39
Inverters, aircraft, electronic controls as applied to	*Aug.*	36
Jet-aircraft condensation trails, the forecasting of	*Aug.*	30
Jet-pressure helicopter—performance data and operating experience	*June*	41
Jet propulsion, the application of, to helicopters	*Sept.*	46
Jet stream, on the possibility of soaring on traveling waves in the	*Dec.*	22
Jet transport operation, civil, and associated meteorological problems, some practical experience with	*Mar.*	47
Jet transport, supersonic, economic aspects of the	*Sept.*	42
Jets, multiple, and an adjacent surface, on the interaction between	*Jan.*	21
JONAS, JULIUS. On the Interaction Between Multiple Jets and an Adjacent Surface	*Jan.*	21
KATZ, LEONHARD. Heat-Transfer Design Problems in Aircraft Electronic Equipment	*May*	61
KAYS, W. M., AND A. L. LONDON. Liquid-Coupled Regenerators for Turboprops	*Oct.*	42
KESSLER, J. R., R. C. TRESEDER, AND M. BROOKS. The Effect of Propeller-Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency	*Nov.*	29
KING, BARRY G. Functional Cockpit Design	*June*	32
Korea, the air war in	*June*	26
KUETTNER, JOACHIM P. On the Possibility of Soaring on Traveling Waves in the Jet Stream	*Dec.*	22
LASSITER, LESLIE W., AND HARVEY H. HUBBARD. Some Aspects of the Aircraft Noise Problem	*July*	28
LENT, MAJOR ROBERT R. Engineers for the U.S.A.F.	*Jan.*	26
LEVERETT, M. C. Aircraft Nuclear Propulsion	*Jan.*	29
LITTLE, D. S. All-Weather Operation Problems (Electronics in Aviation Symposium)	*May*	46
LONDON, A. L., AND W. M. KAYS. Liquid-Coupled Regenerators for Turboprops	*Oct.*	42
LOUGHBOROUGH, D. L. The Physics of the Mechanical Removal of Ice from Aircraft	*Feb.*	29
MASEFIELD, PETER G. The Air Transport Business—from the British Point of View	*Apr.*	61
Materials—		
Flexural Fatigue Strength of Anodized 24ST Aluminum-Alloy Sheet, Charles B. Cliett	*Dec.*	29
New Components for Air-Frame Construction, John F. Faulkner and John H. Alden	*Oct.*	28
Titanium, William S. Cockrell	*Mar.*	44
Use of a Low-Density Core Material in Aircraft Structures, Raymond J. Moore and John M. Ellison	*Sept.*	52
Mathematics—		
Simplified Mathematical Forms for Engineering Use, Ralph H. Upson	*Feb.*	35
MEREWETHER, A. F., AND F. C. WHITE. Storm and Clear Air Turbulence	*May*	57

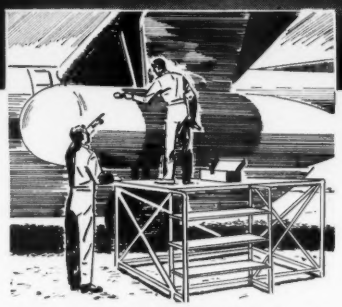
Page

50
42
39
36
30
41
46
22
47
42
21
21
61
42
29
32
26
22
28
26
29
46
42
29
61
29
28
44
52
35
57

	Month	Page
Meteorology—		
The Forecasting of Jet-Aircraft Condensation Trails, H. Appleman	*Aug.*	30
A Meteorological Analysis of Reports of Turbulence Encountered by Aircraft in Clear Air, Conrad P. Mook	*Sept.*	22
On the Possibility of Soaring on Traveling Waves in the Jet Stream, Joachim P. Kuettner	*Dec.*	22
Some Practical Experience with Civil Jet Transport Operation and Associated Meteorological Problems, A. C. Campbell Orde	*Mar.*	47
Storm and Clear Air Turbulence, A. F. Merewether and F. C. White	*May*	57
Military Aviation—		
The Air War in Korea, Gen. Laurence C. Craigie	*June*	26
MILLIKAN, CLARK B. The Guided Missile—Precocious Problem Child of the Military Art	*Apr.*	52
Missiles—		
The Guided Missile—Precocious Problem Child of the Military Art, Clark B. Millikan	*Apr.*	52
Pilotless Aircraft—The Establishment of Structural Design Criteria, Robert Goldin	*Nov.*	22
The Viking Rocket, W. G. Purdy	*Jan.*	16
MOOK, CONRAD P. A Meteorological Analysis of Reports of Turbulence Encountered by Aircraft in Clear Air	*Sept.*	22
MOORE, RAYMOND J., AND JOHN M. ELLISON. Use of a Low-Density Core Material in Aircraft Structures	*Sept.*	52
MORTON, J. B. Present Status of Transistor Development	*May*	34
MOSS, CAPT. WILLIAM W. The Air-Line Pilots Look at Safety	*Apr.*	46
Necrology—		
Bartlett, Richard L.	*Aug.*	54
Bradley, Major Gen. Follett	*Oct.*	19
Cleveland, E. W. ("Pop")	*Oct.*	19
Dunwoody, Col. Halsey	*Nov.*	66
Gardner, Margaret K.	*June*	19
Geeslin, David M.	*Nov.*	66
Hodgson, John Edmund	*Aug.*	54
Hoff, William C.	*Sept.*	19
Hoover, Herbert H.	*Nov.*	66
Kelly, Major Patrick L.	*Feb.*	20
Lord, Leland H.	*May*	23
McDonnell, Col. James A.	*Dec.*	18
McPherson, Albert E.	*Dec.*	18
Messerschmitt, Ens. Richard C.	*June*	66
Mortland, Major Robert A.	*June*	66
Newell, Joseph S.	*July*	57
Parker, J. Brooks B.	*Feb.*	21
Paulson, George M.	*Feb.*	21
Post, Col. Augustus	*Dec.*	18
Schoch, Edwin F.	*Jan.*	43
Schwartz, Eli	*June*	66
Sparrow, Stanwood W.	*Nov.*	66
Teague, Emmett C.	*Nov.*	66
Thelander, William G.	*July*	57
Vye, Stanley A.	*Nov.*	68
Walsh, Raycroft	*Nov.*	68
Welch, Comdr. Frank, Jr.	*Mar.*	28
Wright, James A.	*Oct.*	19
Noise problem, aircraft, some aspects of the	*July*	28
Nuclear propulsion, aircraft	*Jan.*	29
ONDERDONK, J. R., J. J. HORAN, AND E. WITKIN. Reduction of Gun-Gas Explosion Hazard in Combat Aircraft	*Mar.*	37

	Month	Page
Performance—		
Some Practical Experience with Civil Jet Transport Operation and Associated Meteorological Problems, A. C. Campbell Orde	*Mar.*	47
Supersonic Flight from the Pilot's View, William B. Bridgeman	*Feb.*	24
PETTIT, K. G., D. FRASER, AND E. H. BOWLER. Criteria for the Design, Assessment, and Control of Icing Protection Systems	*July*	44
POWERS, CAPTAIN PATRICK W. A Miniature Supersonic Wind Tunnel	*Dec.*	38
Prestall detector, vane-type, theory of operation of the	*Feb.*	39
Propellers—		
The Effect of Propeller-Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency, R. C. Treseder, M. Brooks, and J. R. Kessler	*Nov.*	29
The High-Speed Propeller, George W. Brady	*July*	22
PURDY, W. G. The Viking Rocket	*Jan.*	16
Radar, airport taxi	*May*	32
Radomes and aircraft design	*May*	69
RAND, FRANK F., JR. The Shock Ignition Engine	*Oct.*	22
RASPET, AUGUST. Boundary-Layer Studies on a Sailplane	*June*	52
Regenerators, liquid-coupled, for turboprops	*Oct.*	42
Research—		
The Research and Development Board, Edwin A. Speakman	*Apr.*	57
RICHARDSON, BOYD. Deceleron—a Feature of the F-89 Scorpion Control System	*Mar.*	34
SCHLIEBEN, ERNEST W. Radomes and Aircraft Design	*May*	69
SCHUERCH, HANS U. Structural Analysis of Swept, Low Aspect Ratio, Multispar Aircraft Wings	*Nov.*	34
Shock ignition engine, the	*Oct.*	22
SPEAKMAN, EDWIN A. The Research and Development Board	*Apr.*	57
Springs, temperature-compensated, for aircraft application	*Aug.*	42
STARR, B. M. Electronic Controls as Applied to Aircraft Inverters	*Aug.*	36
STIEGLITZ, WILLIAM I. Cockpit Design and Safety	*Oct.*	36
Stress Analysis and Structures—		
Pilotless Aircraft—The Establishment of Structural Design Criteria, Robert Goldin	*Nov.*	22
Structural Analysis of Swept, Low Aspect Ratio, Multispar Aircraft Wings, Hans U. Schuerch	*Nov.*	34
Supersonic flight from the pilot's view	*Feb.*	24
TEMPLETON, R. R. Flight Testing and Operational Problems on an Afterburner-Equipped Turbojet Installation	*Dec.*	32
Titanium	*Mar.*	44
Transistor development, present status of	*May*	34
TRESEDER, R. C., M. BROOKS, AND J. R. KESSLER. The Effect of Propeller-Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency	*Nov.*	29
TRUXAL, JOHN G., HAROLD M. DEGROFF, RAY C. BINDER, AND J. ROBERT BURNETT. Fundamental Aspects of a Hydraulic-Type-Powered Flight-Control System	*Nov.*	42

GREATER SAFETY through EXTERNAL FUEL TANKS



RAPID AND EFFICIENT FUELING...under-wing external tanks provide quick and efficient fueling without specialized fueling equipment. This is an *exclusive* feature of the Fairchild C-119H.

EASY ACCESSIBILITY...external tanks allow ready access to all operating components of fuel system...make fueling of the new Fairchild C-119 H easier, safer and quicker.

AUTOMATIC COCKPIT CONTROL...is readily accessible to pilot...and complicated fuel selection systems are eliminated. Trim, as effected by fuel consumption, remains constant.

FEATURES of the new C-119H

Increased Wing Surfaces • Larger Flight Control Surfaces Improved Stability and Control • Increased Payload and Better Cargo Distribution • Greater Combat Range • Lower Stall and Jump Speeds • Shorter Take-Offs and Landings • Greater Tail Clearance • External Fuel System • More Efficient Heating System Rough Field Landing Gear • Crew Bail-Out Chute

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

Other Divisions: Guided Missiles Division, Wyandanch, L.I., N.Y. • Engine Division, Farmingdale, N.Y. • Stratos Division, Bay Shore, L.I., N.Y.

AIRCRAFT APPROVED

V5 Solenoid STAINLESS STEEL Valves

THREE-WAY NORMALLY OPEN AND NORMALLY CLOSED

WEIGHT ONLY 1¼ LBS. APPROX. 3½" HIGH

Soft synthetic rubber inserts in plunger prevent leakage...Spring loaded for positive action...Power consumption approx. 10 watts...Usable in any position...Operating pressure to 150 P.S.I....Fluid connections to suit your specifications.

Some models for aircraft, such as valve illustrated, have Yellow Dot approval. Other solenoid aircraft valves available and under development for pressures to 3,000 P.S.I.

Two-way normally open and normally closed solenoid valves for special media such as liquid oxygen, nitric acid and concentrated hydrogen peroxide are also available in a variety of sizes. Inquiries regarding your solenoid valve problems are welcomed.

SKINNER ELECTRIC VALVES

Skinner ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
143 Belden Ave., Norwalk, Conn.

"The Company We Keep"

THE EMERSON ELECTRIC MFG CO
8100 FLORISSANT AVENUE
ST LOUIS 21, MO

GENERAL ELECTRIC COMPANY
APPARATUS SALES DIVISION

INDIANA GEAR WORKS INCORPORATED

THE PIERCE GOVERNOR COMPANY, INC.

WESTINGHOUSE ELECTRIC CORPORATION

A representative exhibit of a few of our customers who have long used Bardwell & McAlister, Inc. as a source of supply for

THE ROSÁN LOCKING SYSTEM

locking steel threaded inserts and studs in all materials softer than steel

You are invited to join our "Good Company" — *write for our Rosán Catalog, Dept. 43.*

ROSÁN Threaded Insert

ROSÁN Locked-in Studs

BARDWELL & McALISTER, Inc.
BURBANK, CALIFORNIA
The Original manufacturer of the Rosan Locking System

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch ounces
...inch pounds
...foot pounds
(All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

This FREE New Booklet Tells You How

In its 28 illustrated pages you'll find the answers to many questions that affect the success of your electroplating on steel. You'll want to read more about:

- ¶ Which costs more: good electrocleaning or poor electrocleaning? *See page 4.*
- ¶ How can cleaning costs be reduced 33% while plating quality is being improved? *See pages 7 and 8.*
- ¶ What are four easy ways to improve the average rinse tank? *See page 10.*
- ¶ What rinsing fault is "an invitation to trouble" in the plating of high-carbon steel? *See page 11.*
- ¶ Why is it better to clean steel with reverse current than with direct current? *See pages 12 to 14.*
- ¶ What causes hydrogen embrittlement during electrocleaning? What is the remedy? *See pages 15 and 16.*

FREE For a copy of *"Four good steps toward better electroplating on steel"*, write to Oakite Products, Inc., 27 Rector St., New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

	Month	Page
Turbojet installation, flight testing and operation problems on an afterburner-equipped	*Dec.*	32
Turboprop airplane, the	*June*	22
Turboprops, liquid-coupled regenerators for	*Oct.*	42
Turbulence encountered by aircraft in clear air, a meteorological analysis of reports of	*Sept.*	22
Turbulence, storm and clear air	*May*	57
UPSON, RALPH H. Simplified Mathematical Forms for Engineering Use	*Feb.*	35
Viking rocket, the	*Jan.*	16
WHITE, F. C., AND A. F. MEREWETHER. Storm and Clear Air Turbulence	*May*	57
Wind Tunnels—		
A Miniature Supersonic Wind Tunnel, Capt. Patrick W. Powers	*Dec.*	38
Wings, structural analysis of swept, low aspect ratio, multispar aircraft	*Nov.*	34
WITKIN, E., J. J. HORAN, AND J. R. ONDERDONK. Reduction of Gun-Gas Explosion Hazard in Combat Aircraft	*Mar.*	37
YOUNG, GALE. The Problems and Promise of Atomic Power	*Aug.*	22

Sherman M. Fairchild Publication Fund Papers

No.		Member Price	Nonmember Price
FF-7	Natural Flight and Related Aeronautics—James L. G. Fitz Patrick.	$2.65	$3.50
FF-6	Wetted Length and Center of Pressure of Vee-Step Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
FF-5	Symposium on Standardization in Technical Information Services for Government Contractors.	$1.00	$1.00
FF-4	Finite Deflections of Curved Sandwich Plates and Sandwich Cylinders—F. K. Teichmann and Chi-Teh Wang.	$0.50	$0.85
FF-3	The Penetration of a Fluid Surface by a Wedge—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
FF-2	A Study of the Flow, Pressures, and Loads Pertaining to Prismatic Vee-Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
AHS-1	Helicopter Flight Research at NACA, Langley—Jack P. Reeder.	$0.35	$0.75
286	Linearized Treatment of Supersonic Flow Through Axi-Symmetric Ducts with Prescribed Wall Contours—Charles E. Mack, Jr., and Ignace I. Kolodner.	$0.75	$1.25
244	Wetted Area and Center of Pressure of Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
229	Wave Profile of a Vee-Planing Surface, Including Test Data on a 30° Deadrise Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
170	Wave Contours in the Wake of a 10° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
169	The Discontinuous Fluid Flow Past an Immersed Wedge—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
168	Wave Contours in the Wake of a 20° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
167	On the Pressure Distribution for a Wedge Penetrating a Fluid Surface—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
166	An Analysis of the Fluid Flow in the Spray Root and Wake Regions of Flat Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
165	Theory and Practice of Sandwich Construction in Aircraft (A Symposium).	$1.85	$2.50
164	Applications of the Theory of Free Molecule Flow to Aeronautics—Holt Ashley.	$1.15	$1.50
106	Measurement of Ambient Air Temperature in Flight—W. Lavern Howland.	$0.35	$0.50
105	An Evaluation of the Importance of Fatigue Phenomena in Aircraft—C. R. Strang, L. R. Jackson, L. F. McBrearty, R. V. Rhode, and R. L. Schleicher.	$0.80	$1.10
104	Tensor Analysis of Aircraft Structural Vibration—Charles E. Mack, Jr.	$1.85	$2.50
102	Electrical Resistance Strain Gages Applied to Wind-Tunnel Balances—Elmer C. Lundquist.	$0.60	$0.80
101	Introduction to Shock Wave Theory—J. G. Coffin.	$2.65	$3.50
100	Blade Pitching Moments of a Two-Bladed Rotor—R. W. Allen.	$0.75	$1.00
126	External Sound Levels of Aircraft—R. L. Field, T. M. Edwards, Pell Kangas, and G. L. Pigman.	$0.75	$1.00

Papers should be ordered by number from:

Publications Department, Institute of the Aeronautical Sciences, Inc.

2 East 64th Street, New York 21, N.Y.

Inconel "X"

may hold the key to your aircraft design problem

Suppose you wanted an alloy that met these specifications:

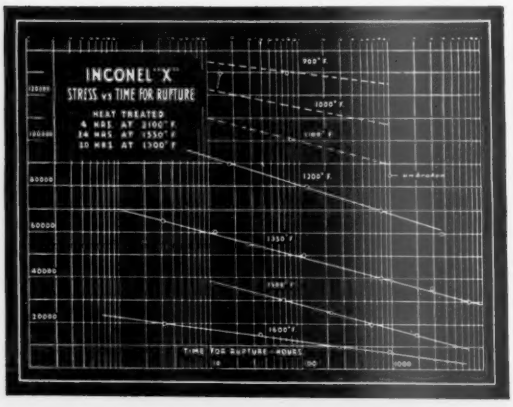
—High elastic limits above 1300° F.
—Outstanding high-temperature strength
—High resistance to oxidation
—Readily fabricated into shape needed
—Weldable by commonly-used methods

Then, Inconel "X"® is your alloy! An age-hardenable alloy, it has every one of the properties mentioned—and a good many to spare. The jet plane afterburner bellows shown above is one application where Inconel "X" filled the bill perfectly; there are countless other aircraft jobs where it also meets all needs.

Let's take a brief look at some of the principal characteristics of Inconel "X":

After suitable heat treatment, it is an unusually strong alloy both at ordinary temperatures and at red heat. It offers excellent resistance to oxidation at high temperatures.

Its stiffness, or modulus of elasticity, is high—about equal to that of alloy steels.



JET AFTERBURNERS boost power, but pose ticklish design problems. Bellows connection between main engine and afterburner must withstand high heat, flex through desired range, prevent hot gases from escaping. This bellows meets all specifications, enables afterburner to supply extra getaway zoom with top efficiency. Designed and manufactured by Solar Aircraft Company, San Diego, Calif., the bellows is made from .010 Inconel "X" sheet which is welded into a circular band—and then corrugated.

Resistance to impact is good, too. And you also have hardness . . . machinability . . . good forging and fabricating qualities. As for welding, this can be accomplished by most of the commonly-used methods including metal arc, inert gas metal arc or atomic hydrogen arc, resistance spot and seam, and resistance butt. In short, Inconel "X" is the kind of metal you can work with—and get the results you want.

Naturally, there is not space enough here to cover all of the properties and characteristics of Inconel "X". So we've prepared an 80-page reference manual and packed it full of the kind of information we thought you'd like to have. You can get a copy—without charge—by dropping us a line and asking for the "Inconel 'X' Data and Information Manual." Write for it—now.

One final—and important—point. Inconel "X", like other nickel alloys, is now on extended delivery because of defense needs. So it is important to include NPA rating and complete end-use information with all orders.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

Nickel INCO Alloys

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL • NICKEL
LOW CARBON NICKEL • DURANICKEL® • INCONEL®
INCONEL "X"® • INCOLOY • NIMONICS

On the UP and UP!

TIRES · TUBES · MAIN GEAR WHEELS AND BRAKES · ROTOR BRAKES
GOODYEAR
"RINGS THE BELL"!
Goodyear is proud of its contributions to the performance of the Bell helicopter — of the equipment it supplies for the "work horse of the air."
MASTER BRAKE CYLINDERS · SPECIAL FUEL CELLS · BASKET ASSEMBLIES

FROM rescue work and delivering mail, to combat service in Korea and countless uses in business and industry—the Bell Aircraft Model 47 helicopter is one of the rising stars in aviation today.

For further details on any Goodyear product for Aviation — tires, tubes, wheels, brakes, Pliocel fuel tanks, bullet-sealing tanks, Iceguard equipment and Airfoam Super-Cushioning — write: Goodyear, Aviation Products Division, Akron 16, Ohio or Los Angeles 54, Calif.

GOODYEAR
AVIATION
PRODUCTS

Iceguard, Airfoam, Pliocel—T. M.'s
The Goodyear Tire & Rubber Company
Akron, Ohio

Forgings for the aircraft industry today demand the utmost in engineering and production techniques and in scientific laboratory control. This massive complicated landing gear component, weighing over 400 pounds, is typical of Wyman-Gordon's forging contribution to the ever-growing progress in aircraft design. In crankshafts for the automotive industry and in all types of aircraft forgings, steel and light alloy, Wyman-Gordon has pioneered in the development of forging "know-how"—there is no substitute for Wyman-Gordon experience.

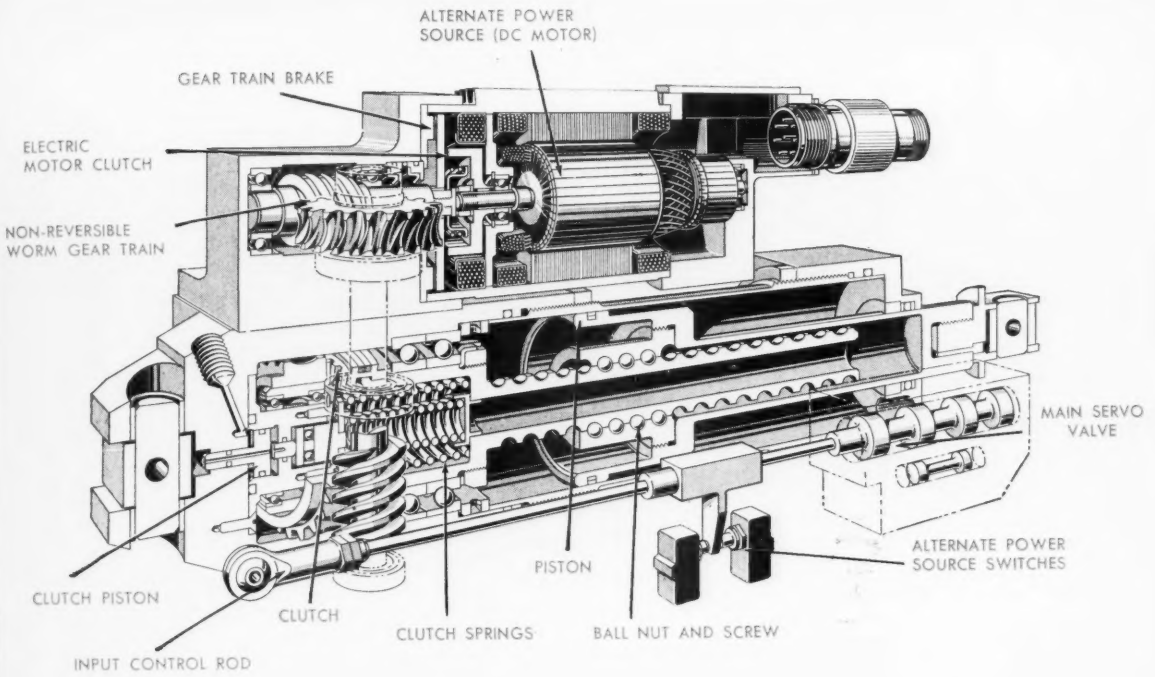
Standard of the Industry for More Than Sixty Years

WYMAN-GORDON

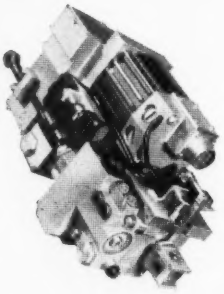
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN



GET NEW DESIGN FREEDOM WITH AEROPRODUCTS SELF-LOCKING ACTUATORS



Instantaneous and positive in action, the new Aeroproducts actuator automatically locks itself in any position. This self-locking feature gives absolute control of any movable part, eliminating design limitations that have heretofore prevented development of many aeronautical advancements.

Aeroproducts actuators may be coupled in series or tandem to give identical, simultaneous control of more than one movable part. The basic design is infinitely variable for hydraulic, pneumatic, electric or manual operation, or any combination of these.

Designs are already in use for variable control surfaces and jet engines. Others are in process for guided missile and various commercial applications.

Actuators now in production are for:

Republic F84F Flyable Tail
McDonnell F3H Horizontal Stabilizer
Others unannounced

APPLICATIONS

- Stabilizer Control
- Jet Engine Variable Nozzle
- Dive Brakes
- Variable Wing Incidence
- Flap Actuation
- Aileron Control
- Variable Wing Sweep
- Bomb Bay Door
- Cargo Door
- Landing Gear
- Turret Control
- Canopy and Seat Control

GM GENERAL MOTORS

Building for today
Designing for tomorrow

AEROPRODUCTS GM

Aeroproducts

ALLISON DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

THE NEW

Polyken®

TAILORED TO YOUR JOB

INDUSTRIAL TAPES

Tape controls pull of 14,500 pound-seconds in JATO unit with Polyken Tape No. 276. Picture taken at the Aerojet Engineering Corp.

Tape holds 18 times the force of gravity

Jet-assisted take-off gets planes air-borne in half the distance it used to take with propellers alone. But when the Aerojet Engineering Corp. first introduced its JATO (Jet-Assisted Take-Off) unit to aircraft, the terrific jet thrust tended to rip the unit apart—to rip the charge loose from its shell.

Aerojet engineers consulted with a Polyken Sales Engineer, who suggested Polyken No. 276—a Fiberglas*-backed tape—to bind the plug and cap assembly that secures the charge to the shell.

Polyken No. 276, strong enough to resist a pull of 14,500 pound-seconds (or 18 times the force of gravity), is strong enough to keep the charge from moving rearward when the powerful energy thrust occurs.

We tell you the JATO story as an example of how industrial tape that's "tailored to your job" can do things you never thought tape could do. Let us study *your* problem, and we'll come up with a tape that will save you money, time and effort. That's a challenge. Won't you take us up on it?

Polyken Industrial Tape, Department of Bauer & Black, Division of The Kendall Company

*Reg. U. S. Pat. Off. by Owens Corning Fiberglas Corp.

Polyken, Dept. AEM, 222 West Adams St., Chicago 6, Ill.

For specifications and further information on No. 276 and other Polyken tapes, please send me your *FREE BOOKLET*, "Tape is a Tool."

Name_____ Title_____

Company_____

Street Address_____

City_____ Zone____ State_____

Research Rides a Rocket

The Naval Research Laboratory's Viking rocket research at White Sands Proving Grounds, N. M., hunts facts, figures and formulas in the upper atmosphere.

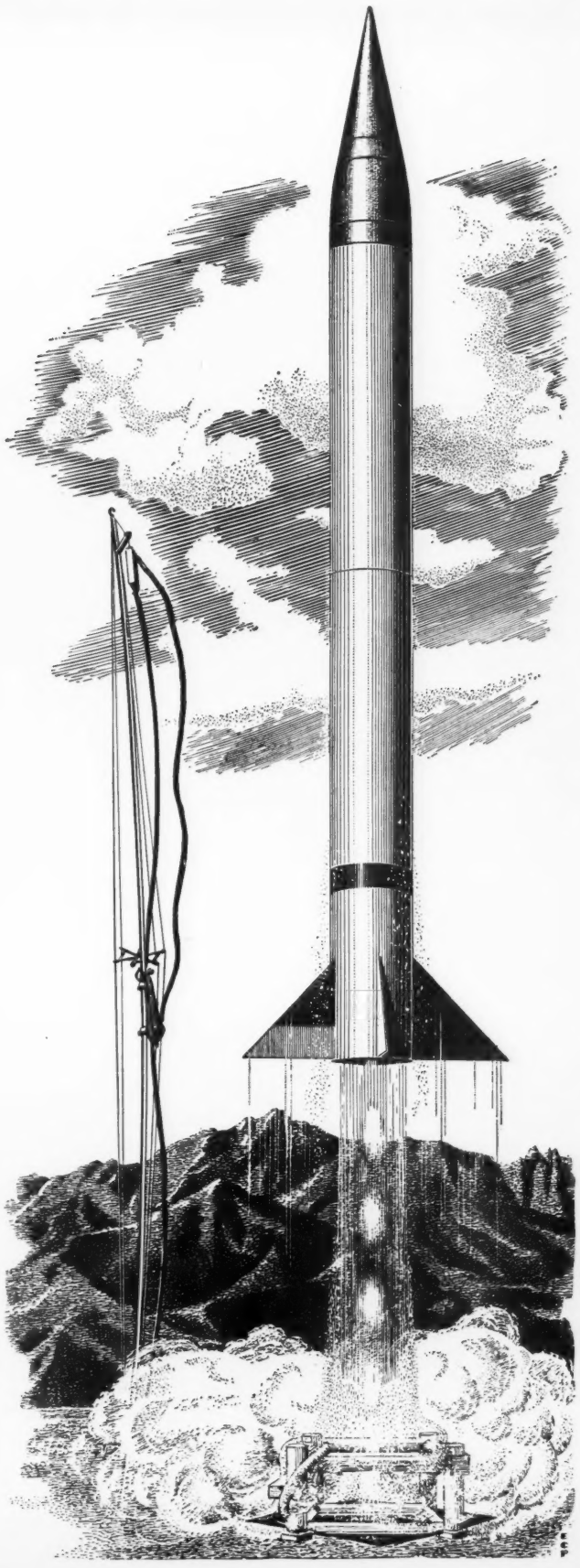
HURTLING far into the blue, Naval Research Laboratory rockets ask questions of the earth's upper atmosphere . . . flash back the answers needed to guide the designers of tomorrow's piloted and pilotless super-altitude systems for peace or war. What are the pressures and temperatures of the earth's atmospheric layers . . . the high-altitude changes in the earth's magnetic field affecting navigational instruments . . . the alterations in radio waves caused by the ionosphere . . . the effects of sun spots on communications equipment out beyond the filtering effects of the earth's heavy atmosphere?

Martin Viking rockets play a major role in this high-altitude flight research program. Last summer, the Viking cracked the world's altitude record for single-stage rockets . . . nosing 136 miles into the heavens at a top speed of 4100 m.p.h. Now, an even more powerful Viking is being readied for launching. The Martin Company is proud to be a partner with the Naval Research Laboratory in these vital activities . . . helping to prove that America's most valuable secret weapon is its scientific leadership! THE GLENN L. MARTIN COMPANY, Baltimore 3, Md.

Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

Developers and Manufacturers of: Navy P5M-1 Marlin seaplanes • Air Force B-57A Canberra night intruder bombers • Air Force B-61 Matador pilotless bombers • Navy P4M-1 Mercator patrol planes • Navy KDM-1 Plover target drones • Navy Viking high-altitude research rockets • Air Force XB-51 developmental tactical bomber • Martin airliners • Guided missiles • Electronic fire control & radar systems • **Leaders in** Building Air Power to Guard the Peace, Air Transport to Serve It.



Warbird's Legs — embryonic stage

Here are the largest closed die forgings ever made—weighing over four tons apiece. Cleveland Pneumatic fashions them into landing gear for the B-36 — mightiest bomber of the skies.

Cleveland Pneumatic's skilled workers perform scores of operations on these primitive columns—including exact machining, expert heat treating, metallurgical control, meticulous inspection. The huge landing gear that finally leaves the plant has the precision qualities of a fine watch. Because of this craftsmanship, the B-36 can thunder in to safe, shock-proof landings.

Behind Cleveland Pneumatic's unexcelled physical facilities stands the unique engineering knowledge gained during 26 years' *specialization* in this vital aviation product. For both these reasons, Cleveland Pneumatic landing gear is universally recognized as *first in the field!*

The Cleveland Pneumatic Tool Company, Cleveland 5, Ohio . . . Established 1894.

CLEVELAND PNEUMATIC

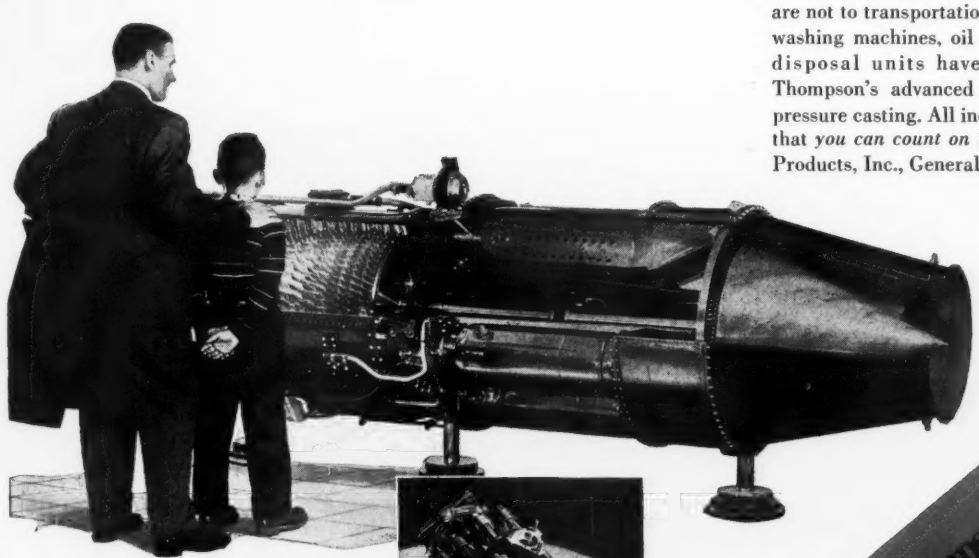
First in the Field! ***Aircraft Landing Gear · Ball Bearing Screws · Actuators***

Catching up with the Sun

MAN'S LONG-TIME DREAM of flying faster than the rotation of the earth has now come true. A Navy plane has flown to an altitude of 13 miles, travelled 1,300 miles per hour, far exceeding the speed of sound. Far faster than the spin of the earth.

Ever since the Wright brothers first left the ground, the goal of the aviation industry has been to make flying faster and safer. Thompson Products has been part and parcel of this industry, striving always to make manufacture more precise and cheaper—to discover new ways to use new metals, to introduce new processes and teach craftsmen new, valuable skills. Today Thompson makes parts and accessories for virtually every plane that flies, every vehicle on farm, rail and highway—and for ships on and under the sea, too.

But Thompson's contributions to industry are not to transportation alone. For example, washing machines, oil burners and garbage disposal units have been improved by Thompson's advanced methods of die and pressure casting. All industry is now learning that *you can count on Thompson.* Thompson Products, Inc., General Offices, Cleveland 17.



This new, boosted gear pump is designed to handle jet engine fuel pressures up to 800 pounds per square inch—with highest efficiency. It is typical of the advanced engineering and production methods of *Thompson Products' Accessories Division.*

You can count on Thompson Products

RYAN

Aircraft and Aeronautical Products

Leaders in High-Temperature Metallurgy

for

JET, PISTON AND ROCKET ENGINES

Research in metallurgy and ceramics...precision machine tools...the latest electric resistance welding equipment... modern production methods...extensive service testing—these are among the reasons why Ryan has long been the leader in fabricating stainless steels and other high-temperature metals for the industry.

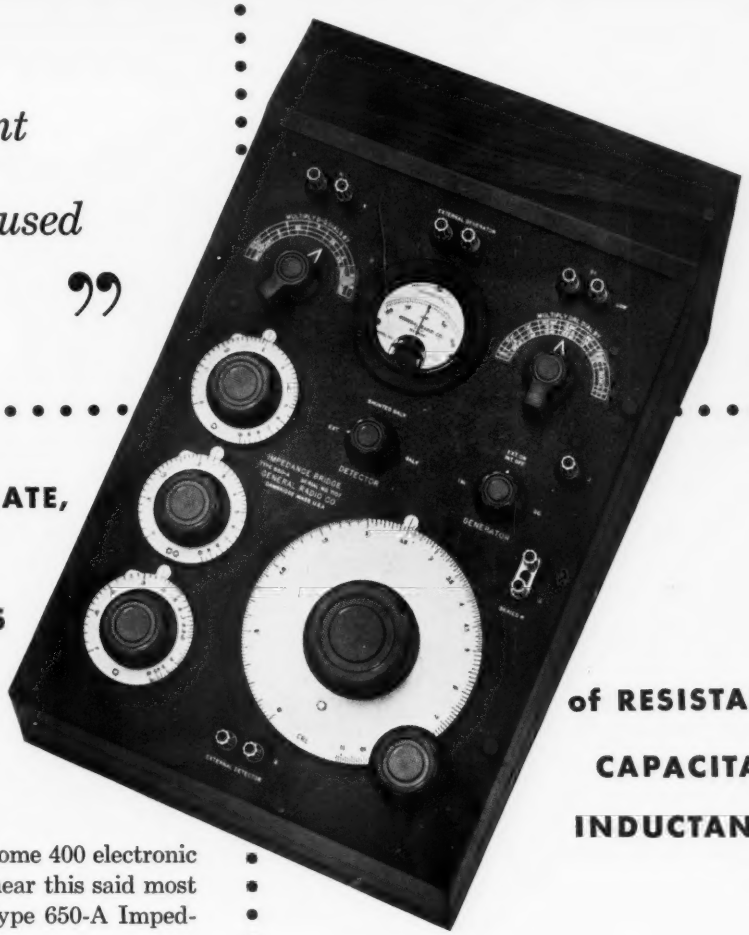
Ryan's electrical resistance welding facilities—the largest and most modern in the aircraft industry—are typical of the fine production equipment available. Ryan pioneered in this field while searching for a fast, clean, weightless way to fuse heat-resistant metals. For high-temperature jet, piston and rocket engine components, the aircraft and aircraft engine industry has learned to RELY ON RYAN.

Ryan SINCE 1922

Metal Products Division • Jet Engine Components • Exhaust Systems • Rocket Assemblies

RYAN AERONAUTICAL COMPANY • LINDBERGH FIELD • SAN DIEGO, CALIF.

"*the Instrument most often used*"



for RAPID, ACCURATE, CONVENIENT MEASUREMENTS of RESISTANCE CAPACITANCE INDUCTANCE

From our entire line of some 400 electronic instrumentation items, we hear this said most often about the versatile Type 650-A Impedance Bridge.

This universal bridge is completely self-contained, portable, light weight, simple to operate, and always set up and ready to measure these important electrical quantities over very wide ranges.

Resistance: 1 milliohm to 1 megohm

Capacitance: 1 micromicrofarad to 100 microfarads

Inductance: 1 microhenry to 100 henrys

Dissipation Factor (R/X): .002 to 1

Storage Factor (X/R or Q): .02 to 1000

The accuracies obtained are more than sufficient for a majority of the routine laboratory measurements of these quantities. Both a-c and d-c power is supplied to the bridge from four dry cells. A zero-center galvanometer is the d-c detector; a 1,000-cycle tone source is used for a-c, with terminals for accessory headset detection. Panel terminals are provided for an external generator for measurements from a few cycles to 10 kilocycles.

Thousands of these bridges are in use in the leading laboratories throughout the world. Once you have used one, you'll find that you can't get along without it.

Type 650-A Impedance Bridge: $260

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

90 West St. NEW YORK 6 920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors
Decade Inductors ☆ Decade Resistors ☆ Distortion Meters
Frequency Meters ☆ Frequency Standards ☆ Geiger Counters
Impedance Bridges ☆ Modulation Meters ☆ Oscillators
Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls
Noise Meters ☆ Null Detectors ☆ Precision Capacitors
Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters
U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes

CONCEIVED *first*

DEVELOPED *first*

PRODUCED *first*

By

Aeroquip

REG. TRADE MARK

12 years of progress in aircraft hose standards have been paced by Aeroquip's 12 years of company history. Through constant research and development, Aeroquip has repeatedly anticipated the ever-changing requirements of the aircraft industry. The assistance and cooperation of B. F. Goodrich Co., The Army Air Forces, U. S. Navy Bureau of Aeronautics and C.A.A. are gratefully acknowledged in the development of these Aeroquip products.

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

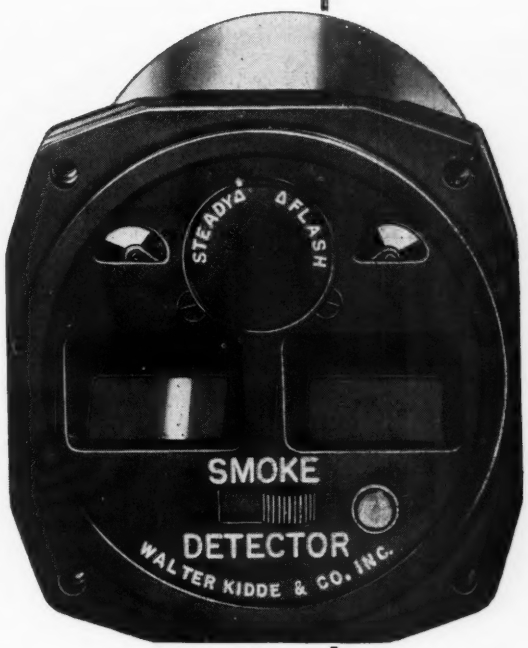
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

NO FALSE ALARMS IN FLIGHT

THE Kidde visual smoke detector offers new advantages in fire protection for aircraft. It is a small, compact, light-weight detector which cannot give false alarms.

Here's how it works: air from cargo compartments is drawn to the detector on the instrument panel. Two viewing windows show a black chamber through which an invisible beam of light passes. The slightest trace of smoke reflects the light beam, showing through one of the windows as a streak of light.

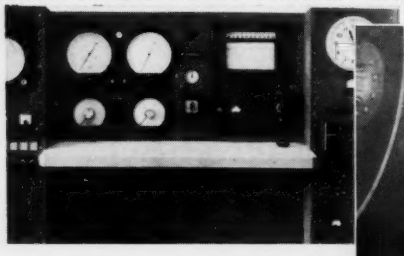
This foolproof detector eliminates false alarms frequently caused by voltage fluctuations and from foreign matter. Write us for full particulars.



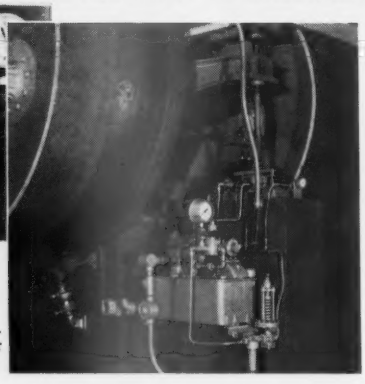
Kidde

Walter Kidde & Company, Inc.
1211 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

EMERY SOLVED THIS WEIGHING PROBLEM



High and low range Emery Force Indicators, each with zero and range selection control, mounted at the central control station.



Emery HF-25 Cell and Hydraulic Flow Metering Equipment mounted at the dynamometer traction wheels below floor level.

FOR THE RICHMOND LABORATORIES

of the California Research Corporation, a wholly-owned subsidiary of the Standard Oil Company of California

THE PROBLEM: Determine the tractive force exerted by automobile driving wheels at all simulated road speeds.

THE SITUATION: Accurate, easy-to-read indication needed up to 2,500 pounds, with extra accuracy below 500 pounds. Remote indication needed as the dynamometer is mounted below floor level with the control station above and at a distance. Measurement must be accurate despite strong vibration through load range, and must remain accurate despite possible heavy shock loads.

THE SOLUTION: Emery Hydraulic Flow Weighing System. An HF-25 Cell is mounted under the torque arm of the dynamometer to "weigh" the power absorbed. Flow control equipment is mounted on a convenient nearby surface.

A CHOICE OF 0-500 or 0-2,500 pound Emery Bourdon Indicator is offered the operator. The low range indicator is marked in one pound steps, while the high range indicator is marked at five pound steps. Indicators are mounted with zeroing controls and range selection switches at the central control station.

FOR HIGHEST ACCURACY the entire Emery System was pre-calibrated under conditions similar to those of the Richmond operation, and shipped ready to be installed by the customer. Error at each indicator is less than 2/10 of 1% of the entire range.

LET EMERY SOLVE YOUR WEIGHING PROBLEM

AT LOW COST for purchase and operation.

WIDE RANGE of stock sizes of Emery Closed Hydraulic, Hydraulic Flow, and Pneumatic Cells permit precision measurement of one to 100,000 pounds. Also special sizes up to 10,000,000 pounds.

WRITE TODAY FOR ALL THE FACTS on how Emery can solve YOUR Force Measuring Problem in Precision Weighing . . . Brake Testing . . . Torque or Torsion Measurements . . . Cable, Chain, or Rope Testing . . . Strength of Materials or Structures . . . Jet Engine Thrust . . . Towing or Traction Tests . . . or some unusual application of your own. Emery Engineers will welcome your most difficult weighing problem.

THE A. H. EMERY CO. **NEW CANAAN 1, CONNECTICUT**

Please send literature on Hydraulic Weighing ( ) Pneumatic Weighing ( ) TEL. NEW CANAAN 9-9595

Our problem is:_____

Max. load_____ % Accuracy required_____

Max. permitted response time lag_____

NAME_____

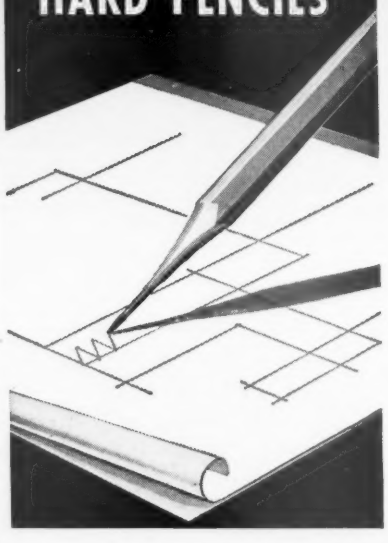
POSITION_____

(Please attach to your business letterhead)

THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

Imperial

TRACING CLOTH FOR HARD PENCILS



● Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

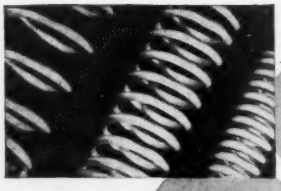
Imperial Pencil Tracing Cloth is right for ink drawings as well.

Imperial

PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE.

"MICRO- ··· PROCESSED"
I·S
BERYLLIUM COPPER SPRINGS



MICRO-PROCESSED SPRINGS

. . . and *your* design problem

Instrument Specialties — through Micro-Processing — builds into and maintains in springs the exact properties that you — the designer — want. By specifying Micro-Processed beryllium copper springs you can concentrate completely on spring function — product performance — and over-all cost. No longer will you have to give thought to the limitations imposed by less versatile spring-making processes — and less tractable materials. The Micro-Processing technique is flexible. It permits [illegible] latitude in design, as hardness is imparted to the springs after forming. Properties to fit specific applications are built into I/S springs — and [illegible] controlled.

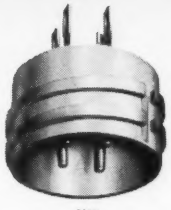
If [illegible] and endurance are of paramount importance in a given spring the [illegible] processing heat treatment is [illegible] impart these properties in [illegible] degree. Tensile strength — [illegible]ance — ductility and other [illegible]racteristics can be similarly emphasized in numerous combinations [illegible]ated by the spring function.

I/S Micro-Processed springs hold shape — dimensions and elastic properties 2 to 10 times more accurately than conventionally made springs.

For [illegible] information on I-S Micro-Processed Springs — write, today, for your free copy of catalog #6 . . . "Micro-Processed Springs of Beryllium Copper".

INSTRUMENT SPECIALTIES CO. INC.
242-D Bergen Blvd. Little Falls, New Jersey
Telephone Little Falls 4-0280

CANNON PLUGS *for hermetic sealed applications*



KH

RKH

HERMETIC SEALED Type RKH Plugs and KH Receptacles mate with their corresponding Cannon RK and K standard fittings. The basic construction of fused vitreous insulation around the contacts is same as GS type. Shell materials and finish are likewise similar. Various types of flange or hex-bulkhead styles may be made to order.

Refer to KH-1 Section in K Bulletin.

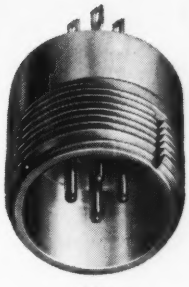
SUB-MINIATURE receptacles of the new Cannon "U" Series are used on miniature switches, relays, transformers, amplifiers, and other sealed components, requiring a true hermetic seal or a connector of sub-miniature size with performance superiority.

"U" plugs have a steel shell and "SILCAN*" insulator, cable relief and moisture resistant sleeve.

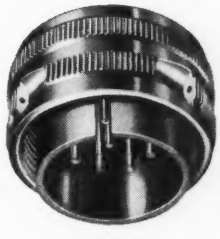
Bayonet-type locking means prevents vibration failure. Rated 1700v. d.c.; 5a. Available in 3, 6, and 12 contact arrangements with one plug style and two receptacles.

**Cannon Electric's special silicone resilient material.*

Refer to U-2 Bulletin



GS02



GS06

GS Types mate with standard AN(MIL) types. These highly successful hermetically sealed plugs (GS06) and receptacles (GS02) pioneered this field and are top quality fittings. Fused vitreous insulation provides a true hermetic seal for relays, position indicators, etc. Shells are steel, finished in cadmium plate and bleached Iridite; coupling nut on plug is natural finish Dural. Eyelet or solder pot terminals.

Built to resist thermal shock, −300°F. to +600°F., surpassing MIL Spec. GS02 Types will withstand operation temperatures 400°F. to 600°F., and pressures as high as 200 to 900 psi; specials to 7500 psi. GS Types approximate AN voltage and current ratings. Wide range of AN layouts available.

See GS-3 section in AN-8 Bulletin for details.

COMING: TYPE "DH" HERMETIC SEALED CONNECTORS SIMILAR TO PRESENT DA-15P

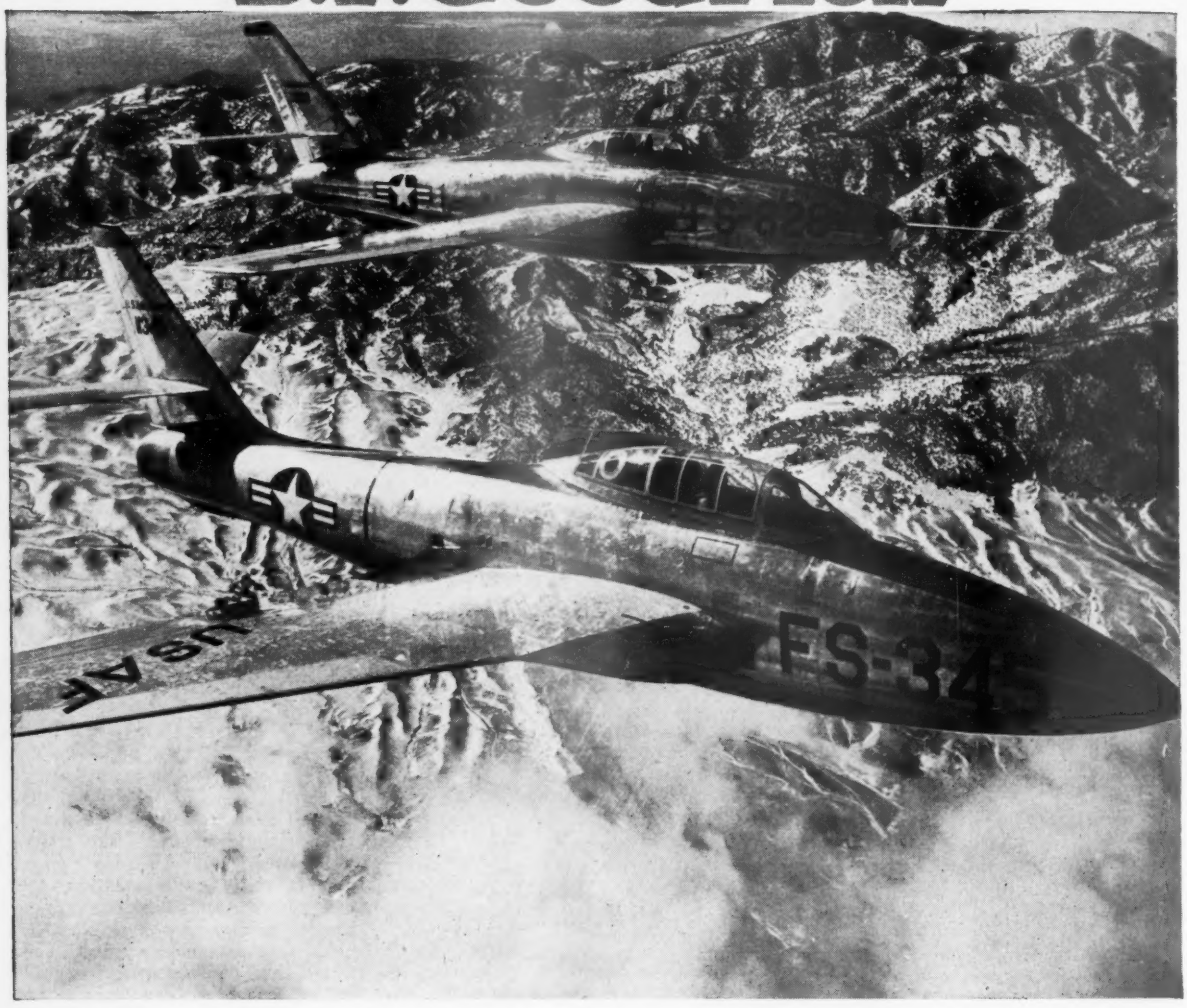
CANNON ELECTRIC

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Co., Dept. L-105, P.O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

B.F.Goodrich



New B. F. Goodrich cell weighs 38% less, carries more fuel

NO SOONER is one model of the Thunderjet in production than designers start again on their perpetual job: shave every possible ounce of weight—make room for more armaments. Save every possible cubic inch inside for fuel—make way for longer flight range.

Republic engineers figured they could carry more fuel if they could use *all* the space in the wings . . . including odd-shaped corners and crevices. But this would add weight, and it looked as though the tricky shapes couldn't be built anyway.

They brought this dual problem to B. F. Goodrich. Here, engineers tackled the assignment three ways. A thinner wall was developed that would still seal as well under gunfire. A way was found for building shapes that would fill out the odd corners, carry more fuel. And finally, a lighter fitting was worked out that saved still more weight.

It all added up to more gallons of fuel and 38% less weight than cells in the early Thunderjets. The new B. F. Goodrich cells have been proved on the famous F-84G, will soon be seeing duty on the new F-84F and RF-84F.

The development of the lighter weight fuel cells is another example of BFG leadership in rubber research and engineering on the problems of aviation. Other B. F. Goodrich products for aviation include tires, wheels and brakes; heated rubber, De-Icers; Avtrim; Plastilock adhesives; Pressure-Sealing Zippers; inflatable seals; Rivnuts; accessories. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

B.F.Goodrich
FIRST IN RUBBER

Index to Advertisers

A

Aeronautical Engineering Catalog ... 83
Aeroproducts-Allison Division, General Motors Corporation ... 5
*Aeroquip Corporation ... 12
*Airborne Accessories Corporation ... 50
Allison Division, General Motors Corporation ... 97
Aluminum Company of America ... 67
American Electric Motors Company ... 52
American Phenolic Corporation ... 65
Arkwright Finishing Company ... 78

B

B. H. Aircraft Company Inc. ... 60
Barber-Colman Company ... 92
Bardwell & McAlister, Inc. ... 112
*Bendix Aviation Corporation
Bendix Products Division ... 49
*Eclipse-Pioneer Division ... 68
*Scintilla Magneto Division ... Inside Back Cover, 72
Bircher Corporation, The ... 51
Boeing Airplane Company ... 101
*Breeze Corporations, Inc. ... 4

C

Cal-Aero Technical Institute ... 99
*Cannon Electric Company ... 15
*Cleveland Pneumatic Tool Company, The ... 8
Cornell Aeronautical Laboratory, Inc. ... 103

D

Dial Light Company of America, The ... 62
Douglas Aircraft Company, Inc. ... 79
Dow Chemical Company, The, Magnesium Department ... 107
Dow Corning Corporation ... 70

E

*Eclipse-Pioneer Division, Bendix Aviation Corporation ... 68
Electric Indicator Company ... 58
*Electrical Engineering & Manufacturing Corporation ... 73
A. H. Emery Company, The ... 14

F

*Fairchild Engine and Airplane Corporation, Fairchild Aircraft Division ... 98, 111
*Foote Bros. Gear and Machine Corporation ... 84
Ford Motor Company ... 102

G

General Electric Company ... 77
General Motors Corporation
Aeroproducts-Allison Division ... 5
Allison Division ... 97
General Radio Company ... 11
G. M. Giannini & Company, Inc. ... 63
B. F. Goodrich Chemical Company ... 87
B. F. Goodrich Company, The, Aeronautical Division ... 16
Goodyear Tire & Rubber Company, The, Aviation Products Division 1

H

Hagen Corporation ... 47

I

Imperial Pencil Tracing Cloth, Keuffel & Esser Company ... 14
Indiana Gear Works, Inc. ... Inside Front Cover
*Industrial Sound Control, Inc. ... 96
Instrument Specialties Company Inc. ... 15
International Nickel Company, Inc. The ... 59, 114

J

*Johns-Manville ... 89

K

Keuffel & Esser Company, Imperial Pencil Tracing Cloth ... 14
Walter Kidde & Company, Inc. ... 13
Kollsman Instrument Corporation ... 54

L

Lamb Electric Company, The ... 94
Lear, Inc., LearCal Division ... 99
Libbey-Owens-Ford Glass Company, Fiber-Glass Division ... 104
Link Aviation, Inc. ... 98

M

Magnetic Amplifiers, Inc. ... 66
Glenn L. Martin Company, The ... 7
*Meletron Corporation ... 53
Minneapolis-Honeywell Regulator Company, Aeronautical Division ... Back Cover
Minnesota Mining and Manufacturing Company, Adhesives and Coatings Division ... 80

N

North American Aviation, Inc. ... 102, 103

O

Oakite Products, Inc. ... 112

P

Pacific Scientific Company ... 95
Piasecki Helicopter Corporation ... 103
Pittsburgh Plate Glass Company, Industrial Paint Division ... 82
Polyken Industrial Tapes, Department of Bauer & Black ... 6

R

*Rohr Aircraft Corporation ... 116
Ryan Aeronautical Company ... 10

S

Sandia Corporation ... 98
*Scintilla Magneto Division, Bendix Aviation Corporation ... Inside Back Cover, 72
Shafer Bearing Corporation ... 56
Skinner Electric Valve Division, The Skinner Chuck Company ... 112
*Sperry Gyroscope Company Division, The Sperry Corporation ... 91
Standard-Thomson Corporation ... 83
P. A. Sturtevant Company ... 112
Sverdrup & Parcel, Inc. ... 102

T

Thompson Products, Inc. ... 9

U

United States Aviation Underwriters Incorporated ... 66
Universal Metal Products, Inc. ... 64

V

Varflex Corporation ... 75
*Vickers, Inc., Division of The Sperry Corporation ... 57

W

Waterman Products Company, Inc. ... 52
Weston Electrical Instrument Corporation ... 109
Wharton & Wilcocks of America Inc. ... 88
*Wittek Manufacturing Company ... 66
Wyman-Gordon Company ... 2

Y

Young Testing Machine Company ... 55

★ Specifications and further information on the aircraft products of these companies will be found in the 1952 AERONAUTICAL ENGINEERING CATALOG

The only publication of its kind devoted exclusively to the aircraft industry, this CATALOG serves as a valuable buyers' and reference guide to sources and specifications on aircraft materials, parts, and accessories. It is distributed annually to Chief Engineers, Designers, Production Heads, and Purchasing Departments of all leading Aircraft, Aircraft Engine, Instrument, Accessory, and Aircraft Parts Manufacturers; Air Transport Companies; Army, Navy, and Governmental Agencies; Research Organizations; Engineering Libraries; etc.

Published Annually by

INSTITUTE OF THE AERONAUTICAL SCIENCES

2 East 64th Street New York 21, N.Y.

jet power packages by

ROHR

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES

ROHR AIRCRAFT CORPORATION CHULA VISTA AND RIVERSIDE CALIFORNIA

THE BENDIX IGNITION ANALYZER GIVES ADVANCE WARNING OF SPARK PLUG FAILURE

Result: ADDED SAFETY

THE POINT OF NO RETURN BECOMES A POINT OF ASSURANCE

The Bendix Ignition Analyzer actually *foresees the future* by predicting the remaining life of spark plugs. With the Ignition Voltage Control the operator can determine the present efficiency of all spark plugs and put the finger on any weakness in the system—even though it has not yet affected the operation. If the control reveals impending trouble, corrective action may be taken *before* material harm takes place. With an airborne installation of the Ignition Analyzer, the test can be made before an over-water flight reaches the point of no return. By viewing the wave forms on the face of the 'scope and comparing with known patterns, the operator can quickly make the *right* choice . . . to return without mishap, to operate at reduced power and prevent complete engine failure or to continue safely at cruising speed.

So, for maximum safety and operating efficiency it pays to make provisions for installation of a Bendix Ignition Analyzer on all your aircraft.

Detailed information available on request.

Costs Less—Does More

The Bendix Ignition Analyzer is available for either airborne or portable-airborne installations. It can be used with either high or low tension magneto or battery ignition. It is the ignition analyzer that can predict spark plug failure before it occurs . . . make an efficient check of more than one spark plug at a time and do so on a large, easy to read screen . . . yet it costs less than comparable analyzers.

Bendix

SCINTILLA MAGNETO DIVISION OF SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan
Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

DEC 16 1952

New aero plant is symbol of Honeywell growth

About a year ago, Honeywell's Aero Division was busting its seams all over Minneapolis. No wonder, then, that Honeywell, world leader in automatic controls since 1885, built this wondrous new plant to house its vigorous offspring.

Within these walls you'll find research and development labs – where tomorrow's aviation control problems are studied. Extensive environment test laboratories – where solutions to today's problems are given tough, practical testing. Production lines—where *proved* Aeronautical Controls are mass-produced.

And behind all of this are more than 4,000 employees, including highly trained research men and engineers of the Honeywell Aeronautical Division, who work with the very best equipment.

Our new plant is a symbol of 11 years growth. In that time our list of precision controls has grown from one, the world's first electronic autopilot, to a line that includes today's vastly improved autopilots for bombers, fighters and helicopters; also turbo regulators, jet engine controls, electronic fuel measurement systems, gyros, actuators and other control equipment.

And this list will grow – because *automatic control* is such an important part of aviation progress. And *automatic control* is Honeywell's business.

MINNEAPOLIS **Honeywell**

H HONEYWELL *Aeronautical Controls*